20 Simulation in Emergency Medicine

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Introduction

Emergency medicine is a specialty with a high decision load, and the decisions are typically high stakes. In addition, emergency physicians work in an environment where effective communications and teamwork are essential to patient safety. These two factors combined with the wide range of uncommon yet critical illnesses and breadth of procedures make simulation training in emergency medicine a necessity. Driven by these demands, the emergency medicine simulation community has been at the forefront of simulation-based assessment and education over the last 10 years. This chapter will provide a description of the state of the art in emergency medicine simulation which is applicable to both emergency medicine educators and educators from other specialties. Much of what has been done well in emergency medicine can be easily applied to a variety of clinical disciples.

Simulation allows both practitioners and students to safely practice medical decision-making and procedural skills without incurring risk to patients [1]. This allows critical learning to occur for the emergency medicine practitioner outside of the uncontrolled and chaotic environment of the emergency department. Initially described and used in the military and in aviation, simulation techniques have been used in the healthcare industry for over 40 years. In 1966 Dr. Stephen Abrahamson and Dr. Judson Denson developed "Sim One" at the University of Southern California [2, 3]. Gaba and DeAnda took the next steps in development of this technology and educational techniques in the 1980s [4]. These initial efforts at lifelike human simulation lead to the now widespread adoption of the technique. In 1999, the first published use of simulation training for the specialty of emergency medicine appeared, detailing an advanced airway course which taught rapid sequence intubation (RSI) [5]. Based on the crew resource model, another landmark study was published in 1999 that described a simulation course to "improve EM clinician performance, increase patient safety, and decrease liability" [6]. Some of the initial descriptions of the use of simulation in emergency medicine education included a description of team training principles [6, 7], a discussion of human responses to the simulated environment [8], and a description of a simulation-based medical education service [9]. Since 2000, the specialty of emergency medicine has been a leader in the development of simulation

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techniques, faculty training, systems integration, research, and policy. There is currently a strong national simulation community in emergency medicine that continues to work on future applications of simulation to high-stakes assessment, maintenance of certification, patient safety, and quality. Indeed, as anesthesiology introduced the use of simulation, emergency medicine quickly helped advance the field in tandem.

Emergency Medicine Simulation History and Organization

Simulation in emergency medicine was first organized through the *Society for Academic Emergency Medicine* (SAEM). In 2002, in response to a growing number of members interested in simulation, the SAEM Simulation Interest Group was formed. The emphasis of this group was to increase collaboration and advance the emerging field of medical simulation. Its inaugural chair, Bill Bond, MD, also served as the EM representative to the national exploratory committee for the establishment of the Society for Medical Simulation, later renamed the Society for Simulation in Healthcare (SSH). As simulation matured within the field of emergency medicine, the SAEM Board of Directors established the Simulation Task Force to represent and support the organizational direction within the field of medical simulation. This group, originally chaired by Jim Gordon, MD, was established in 2005 and elevated to a standing committee in 2007, the SAEM Technology in Medical Education Committee. In 2008, the two groups worked together to sponsor an Agency for Healthcare Research and Quality (AHRQ) funded Consensus Conference entitled "The Science of Simulation in Healthcare: Defining and Developing Clinical Expertise" [10], which was held at the SAEM Annual Meeting in Washington DC. In 2009, the Simulation Interest Group and Technology in Medical Education Committee were combined to form the SAEM Simulation Academy, encompassing the goals, membership, leadership, and direction of both groups. This effort was spearheaded by Steve McLaughlin, MD. Rosemarie Fernandez, MD, was named the inaugural chair. The current focus of the Simulation Academy is to enhance education, research, and patient safety through the use of simulation. Recent Simulation Academy programs include consultative services for academic EM departments establishing simulation programs, establishing collaborative research projects, and administering the SimWars competition, created and developed in 2007 by Yasuharu Okuda, MD, Steven. A. Godwin, MD, and Scott Weingart, MD, at national and international meetings. The *Council of Emergency Medicine Residency Directors*, another EM national organization, set up a task force to create an oral board/simulation case bank. The simulation case development began in 2009, in collaboration with the Simulation Academy and the Clerkship Directors in Emergency Medicine, and currently has over 75 assigned cases. The *American College of Emergency Physicians* (ACEP) has a Simulation Subcommittee under the broader Education Committee. The focus of the ACEP Simulation Subcommittee is to investigate and create opportunities in the use of simulation for continuing medical education. Lastly, SSH has a Special Interest Group (SIG) in emergency medicine, which is dedicated to improving the quality of emergency care using simulation. This interdisciplinary group works together to support programs at the International Meeting on Simulation in Healthcare (IMSH) as well as liaises with other leading EM organizations to the SSH.

The Science of Simulation in Emergency Medicine

Medical Students

With the growth of simulation in emergency medicine (EM) resident education as described in other sections of this chapter, it follows naturally that these programs would bring simulation to their medical student clerkships as well. However, a complete description of the current state of EM-focused simulation in medical schools is difficult as we have incomplete data from which to draw. Descriptions of medical student use of all varieties of simulation exist, such as standardized patients, computer-based training, procedural trainers, and mannequin-based simulation. Chakravarthy et al. published the most comprehensive review of simulation in medical student EM education to date [11], which examined the prevalence and research behind simulation in EM education focused on students.

Wide variation in the methods and use of simulation exists in medical schools, and EM education is no exception. A recent survey gathered data about the current state and challenges in simulation for EM clerkships [12]. In 60 institutions surveyed, 83% reported simulation was available to students during preclinical years. The majority of clerkships included some simulation, including 79% using high-fidelity simulation, 55% using task trainers, and 30% using low-fidelity simulations. The majority of programs spend less than 25% of their core curriculum hours in simulation exercises, but actual time reported varied widely. When asked about barriers to increased simulation in their clerkships, 88% reported faculty time as a barrier, with available time and financial considerations being the next largest barriers reported by 47 and 42% of respondents, respectively. Another survey of 32 clerkship directors with EM rotations that include third-year medical students reported that 60% included some simulation exposure, including one that used simulation as an evaluation tool for the students [13].

While we have increasing data demonstrating the use and effectiveness of simulation in graduate emergency medicine programs, data on EM simulation in medical schools remains sparse. Most outcome data in medical student simulation has been completed in other specialties such as anesthesiology and obstetrics, but some of the skills studied, such as resuscitation and airway management, apply directly to EM. Simulation has been well described for use in teaching resuscitation skills to medical students [14, 15].

Over the past few years, there has been a growth in articles relevant to EM clerkship use, and these are well reviewed in the Chakravarthy article [11]. Some focus on demonstrating positive student perceptions of simulation exercises [16–18], others on simulation as a superior teaching tool versus traditional methodologies [19–22]. Not all studies have demonstrated positive outcome studies favoring simulation. One study by Schwartz et al. showed no difference in examination scores between a Human Patient Simulator group and a Case-Based Learning group [23]. Another showed no difference in posttest scores between groups randomized to simulation exercises versus lecture on two subjects [24]. These mixed but promising studies show a need for more high-quality research into the effectiveness of simulation versus other modalities in EM student education and a need to examine which subjects and competencies are best taught by simulation. In addition, studies describing which students may benefit most from this sort of learning are also needed, as it is entirely possible that simulation is not a "one size fits all" teaching modality.

Simulation as a patient safety and patient satisfaction tool has also been explored in at the medical student level. It has been demonstrated that emergency department patients' perceptions of students and their willingness to allow students to perform a procedure on them are improved if the patients are told the students have shown competence in that procedure on a simulator [25]. Procedural training eventually requires practice on real patients and improving the patients' comfort, and willingness to allow students to learn procedures on them is important. Patients also deserve students who are prepared in the most thorough way before being subjected to procedures to reduce the likelihood for error and harm. As the majority of research and published descriptions of successful simulation in EM has been completed with residents, a real opportunity exists for future research looking at using simulation for EM education in medical students. This position is reflected in statements from the SAEM Simulation Task Force research agenda from 2007 [26].

In summary, there are variations in the use of simulation in undergraduate EM education but growing evidence that it can be successful. The majority of undergraduate EM programs are using some simulation although the amount and types of simulation are not standardized and vary from completely replacing all didactics to nonexistent. Simulation would likely be used more if not for some well-described barriers such as faculty time and financial considerations. There is evidence that simulation can be a superior teaching tool to some more traditional methods for teaching students EM concepts and competencies, but further study is still needed in this area.

Graduate Medical Education

Simulation has been increasingly used in Graduate Medical Education (GME) programs for emergency medicine resident training. During the time period from 2003 to 2008, emergency medicine training programs reported that the use of some form of simulation increased from 29 to 91% [27]. Simulation has been shown to be an effective means of EM resident education and evaluation along the entire spectrum, from clinical knowledge and skill acquisition to teamwork training and development of interpersonal skills and professionalism. A comprehensive review of simulation in graduate medical education for emergency medicine was published in 2008 [28].

Most EM programs offering simulation-based teaching have added selected simulation modalities to their existing curriculum. Binstadt et al. described a revamped EM curriculum utilizing a comprehensive approach to simulation-based teaching [29]. McLaughlin et al. also describe a comprehensive 3-year curriculum that includes graduated complexity to match advancing PGY levels [30]. The Emergency Medicine Residency at the Mayo Clinic has also transitioned 20% of the core curriculum to simulation-based teaching without segregating junior and senior residents for the cases or debriefing sessions [31].

The standard educational conference is also being improved through the incorporation of simulation as an educational tool. Emergency medicine residents generally rate simulation-based training sessions higher than traditional lectures [32]. There are existing models which demonstrate how to include simulation scenarios, standardized patients, task trainers, and small-group sessions within the format of a 5-h resident conference [33]. Simulation has also been shown as an effective alternative for morbidity and mortality (M&M) resident conferences [34]. In a simulation-based M&M conference, the clinical scenario in question is actually re-created using simulation. The audience then actively evaluates the case in real time which increases learner involvement.

Simulation also appears to be an effective assessment tool for residency training programs [35]. The studies validating assessment tools for use in simulation in emergency medicine are increasing [35–38]. A study of pediatric residents found that high-fidelity medical simulation can assess a resident's ability to manage a pediatric airway [39]. A study by McLaughlin et al. used simulation-based assessment as part of a comprehensive assessment program to demonstrate competence of emergency medicine residents in the care of victims of sexual assault [40]. This type of study is an example of how simulation can be used effectively along with other assessment tools to capture a more full picture of a learner's performance. Simulation-based assessment has the potential to revolutionize competence assessment and may serve as a critical tool to accomplish the objectives of the ACGME Outcomes Project. Bond et al. identified that simulation was most useful for addressing the patient care, system-based practice (SBP), and interpersonal skills portions of the core competencies [41]. The system-based practice competency addresses the enormous variety of medical and social conditions as well as medical and nonmedical interactions that an emergency physician will encounter on a daily basis. This specific competency was addressed via a simulation-based curriculum by Wang and Vozenilek [42]. Using direct observation by attending physicians and coresidents, checklist evaluation of competency criteria, and videotape-based debriefing, this curriculum emphasized SBP objectives such as appropriate consultation, patient disposition, and resource utilization. Simulation has also been shown to be an effective way to assess multiple scenarios and procedures, encompassing the medical knowledge competency [43]. Professionalism in EM residents can also be assessed using a simulated environment as demonstrated by Gisondi et al. [36]. They evaluated residents by observing a scenario that focused on patient confidentiality, informed consent, withdrawal of care, practicing procedures on the recently deceased, and the use of do-not-attempt resuscitation orders. With direct observation, potential weaknesses and areas for improvement were identified in different classes of residents, as well as demonstrating improved professionalism as they progressed during the training.

Caring for multiple patients simultaneously is also an important skill for emergency medicine physicians and represents a high-risk aspect of their practice. Simulation scenarios with two or more simultaneous patients are being used to develop multitasking, crew resource management, and decision-making skills without risk to actual patients [44]. Simulation-based assessments should also reliably discriminate between novice and experienced clinicians. Evaluation tools previously developed for emergency medicine oral examinations appear to be effective when used in a simulator-based testing environment [35]. Crisis resource management in critically ill patients was assessed in residents using a novel rating scale and found significant differences between first-year and third-year residents [45]. Another study of residents in a pediatric training program found that simulation can reliably measure and discriminate competence [46]. A study of 44 emergency medicine residents found significant differences between novice and experienced resident physicians who were tested on a patient care competency using time-based goals for decision-making [37]. These studies suggest that well-designed simulation-based assessment is an effective way to monitor the progress of residents through the training program. Developing guidelines for training that are geared towards outcomes rather than processes will be essential under the new accreditation model for GME.

There are opportunities for simulation-based education to satisfy specific training requirements for emergency medicine. Currently, the chief complaint competency, resuscitation competency, and procedural competency requirements can all be effectively assessed using a simulation model. Although simulation is potentially well suited to such high-stakes assessment until it is validated as described above, it should only be used in combination with other metrics with proven performance [46–49]. Currently, in emergency medicine, simulation-based assessment is used more often and very effectively for formative assessment. Simulation helps provide a medium by which faculty can objectively identify areas in which a learner needs improvement. When used for formative feedback, the goal is to improve performance through deliberate practice.

Simulation has become an integral part of emergency medicine graduate medical education in the last 10 years showing growth in both numbers of programs using simulation and the sophistication of the curriculum and assessments. The future of simulation in GME will likely include an increased role in high-stakes assessment as well as more robust research programs.

Continuing Medical Education

Nationally, the role of simulation in continuing medical education (CME) has developed at a slower pace than that of GME and undergraduate medical education (UME). Currently, there is very little data on the role of simulation in CME for emergency medicine. However, there are a number of courses for practicing emergency physicians, which use simulation-based training to teach particular skills such as airway management, procedural sedation, or ultrasound. Most of these courses are independent and not organized into a comprehensive quality-focused CME program. In addition, there are some courses that have used simulation to develop teamwork in practicing emergency physicians. Some medical education companies offer *AMA PRA Cat 2 CME*™ for completion of screen-based simulation training online. This limited application of simulation to CME in emergency medicine is beginning to change as it is increasingly seen as a tool to address the identification and closure of many performance gaps for the practicing emergency physician. This change is partially driven by the maintenance of certification (MOC)/licensure (MOL) processes and hospital credentialing requirements. Emergency medicine would be a likely candidate to develop simulation-based MOC requirements similar to anesthesiology.

Recently, a review of the literature, evidence, and best practices in CME was completed by the AHRQ [50]. This was followed up with a review article discussing the future of simulation in CME and lessons from GME/UME [51]. The conclusions of the AHRQ study were that the evidence is limited but does point to the effectiveness of simulation-based teaching of psychomotor and communications skills. It also noted that current assessment tools are limited and that simulation is hindered by its somewhat high cost. Emergency medicine educators should take away from these studies the message that quality simulation-based education in CME requires prepared teachers, integrated curriculum, quality assessment tools, and strong alignment with other patient safety and quality efforts. CME providers should also build curricula that foster mastery learning, deliberate practice, and recognition and attention to cultural barriers within the medical profession.

Interprofessional Education and Emergency Medical Services

The Institute of Medicine recommends that "all health professionals should be educated to deliver patient-centered care as members of an interdisciplinary team, emphasizing evidence-based practice, quality improvement approaches, and informatics" [52]. The emergency department is rich with opportunities to implement simulation-based interprofessional education (IPE) for teams of physicians, nurses, pre-hospital personnel, respiratory therapists, social workers, pharmacists, radiology technicians, other allied health professionals, and administrative support personnel.

Simulation provides an effective modality to enable interprofessional teams to improve knowledge and attitudes regarding teamwork and to identify effective team skills [53]. Integrating IPE principles with simulation methods allows innovative educators to pull from the strengths of each to design realistic programs that have significant potential to affect the clinical environment [54].

Simulation scenarios can and should be designed with each of the many involved disciplines in mind. Using both familiar and unusual case scenarios, ideas are generated directly from the real experiences of all disciplines, although it is important to develop a sustainable curriculum to address the long-term goals of the educational program [29]. Several scenarios can be linked to simulate a "regular workday" both to identify systems issues and to develop procedures addressing patient surges and disaster response.

At the inception of a program, representatives should collaborate to develop the desired learning objectives. Scenarios, as well as evaluation tools and metrics, should include elements specific to each discipline while simultaneously incorporating shared goals that bridge professional boundaries. Immediate debriefing incorporating facilitators from each professional group will serve to involve all individuals as active learners. A longitudinal collaborative evaluation process, addressing evolving objectives and program improvements, will help assure the sustainability of IPE programs. There are numerous examples of simulation-based team training in emergency medicine which are discussed in detail in one of the following sections.

There is also a growing body of literature to support simulation-based training and assessment in the emergency medicine services (EMS) community. Simulation has been used effectively for new skills acquisition [55], for identification of gaps in knowledge or skills [56], and for assessment [57]. Simulation has also been demonstrated to be an effective tool for teaching advanced disaster management skills and response to weapons of mass destruction [58]. Paramedic students are similar to other learners in that they find current simulation technology to be adequately realistic and effective [59, 60]. Simulation can effectively address many of the barriers to EMS education including exposure to serious but uncommon events, skills maintenance, and recertification. It should be considered a critical tool in modern EMS education.

The Art of Simulation in Emergency Medicine

Case Development and Scenario Design

There have been a variety of different approaches to case development in emergency medicine. The overall theme has been one of collaboration across the national emergency medicine organizations. Two specific pathways to case development include (1) creating tools and techniques for local/institutional level case development and (2) organized larger initiatives to create peer-reviewed case banks for use by multiple programs. For local case development there are a large number of different approaches, models, and templates. One approach used at several centers is the "Eight-Step Model" of scenario design [28] (Table 20.1). This model was developed at the University of New Mexico and is one example of a structured approach to case development. Often case development is supported by the use of a structured template for recording the case material, objectives, and assessment tools. Emergency medicine educators have also successfully used a second approach detailed below.

Starting in 2010 there was an initiative by the Council of Residency Directors in emergency medicine and the Simulation Academy of the Society of Academic Emergency Medicine to update and revise an existing bank of cases used for oral examination practice. This initiative focused on building

Table 20.1 The eight steps of scenario design

1. Objectives: Create learning/assessment objectives
2. Learners: Incorporate background/needs of learners
3. Patient: Create a patient vignette to meet objectives which also must elicit the performance you want to observe
4. Flow: Develop flow of simulation scenario including initial parameters, planned events/transitions, and response to anticipated interventions
5. Environment: Design room, props, and script and determine simulator requirements
6. Assessment: Develop assessment tools and methods
7. Debriefing: Determine debriefing issues and mislearning opportunities
8. Debugging: Test the scenario, equipment, learner responses, timing, assessment tools, and methods through extensive pilot testing

Fig. 20.1 Pediatric simulation lab

a shared bank of cases following a standard template which could be used by residency programs for simulation-based education, mock oral cases, or as an assessment resource. Each case was submitted by experienced simulation faculty and went through a rigorous peer-review process. The cases are accessible to all residency program members from emergency medicine. There are secure cases designed to be used for resident assessment as well as open-access cases which can be used to teaching or practice. This open-access portion of the website is available at www.cordem.org.

Equipment and Space

There has been strong growth in the use of simulation technology in emergency medicine since 2000, with the majority of accredited residency programs in the United States currently using some form of mannequin-based simulation [27]. Along with this trend has come a proliferation of simulation centers with technological resources and space dedicated to high-end clinical and procedural simulation, videoconferencing, and standardized patient encounters. Of the three professional organizations that have created accreditation standards for simulation programs (the American Society of Anesthesiologists, the American College of Surgeons, and the Society for Simulation in Healthcare), only the American College of Surgeons lists specific space and technological requirements for simulation centers. The SAEM Simulation Academy does not emphasize hardware or space requirements for simulation programs, recognizing that these are highly dependent on the educational goals and the resources available to individual programs [61]. Additionally, as high-fidelity simulators become increasingly portable and require less supporting equipment, it becomes less clear that a "fixed" simulation center is advantageous in every setting [28]. Successful in situ simulation can be conducted even within the confines of an ambulance, and its use in the clinical environment may indeed represent the natural evolution of the technology [62]. The following example provides a description of a dedicated space used for emergency medicine simulation but is not intended to be prescriptive.

For high-fidelity patient care scenarios, the space used for simulation should match the clinical environment in terms of equipment, patient monitoring, and available personnel as closely as possible (Fig. 20.1). For emergency medicine-specific simulation, this includes a basic cardiac monitor capable of displaying simulated vital signs and which can be manipulated remotely, IV supplies (IV catheters and start-kits, tubing, fluids, and an IV pole), equipment for managing airway emergencies (wall-mounted suction, bag–valve–mask, intubation tray), and a defibrillator and code cart. The added value of having functional equipment (e.g., suction, supplemental oxygen, defibrillator capable of delivering shocks) is debatable and should not be viewed as requisite for successful simulation. Additional equipment such as ventilators lends heightened realism to scenarios but at considerable cost and need for additional storage space. In situ simulation can mitigate many of these challenges, as scenarios can be conducted in the clinical environment with actual equipment.

In addition to the simulation space, consideration should be given to a control area from which to conduct the scenario. Ideally, this should include a "line of sight" (such as a one-way mirror) to the simulation area in order to facilitate quick adjustments during scenarios in progress, as well as adequate sound proofing to prevent interference from those conducting the scenario (Fig. 20.2). This may require some creativity in the case of in situ simulation, where the ability to create adequate distance for those conducting the simulation can be difficult. In these instances, a well-placed curtain or an adjacent doorway may be the best option. An area for observation and debriefing, ideally in a location adjacent or close to the simulation area,

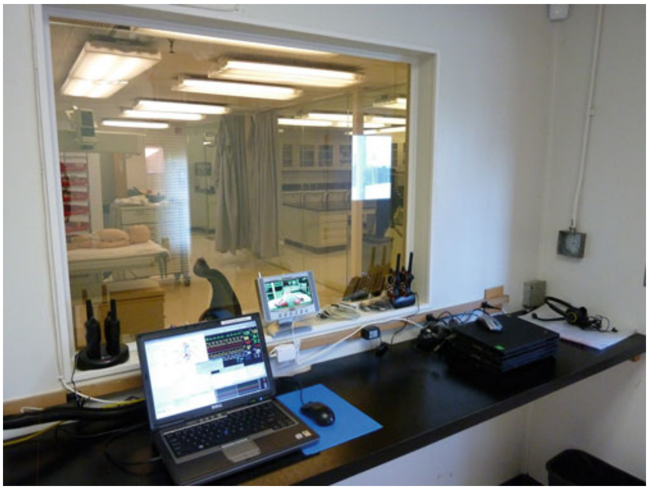

Fig. 20.2 Control room showing view of simulation area

Fig. 20.3 Debriefing room

should also be available (Fig. 20.3). Depending on the audiovisual capabilities of the facility, this space can be used for video monitoring of ongoing simulation as well as post hoc review for debriefing. Finally, it should be emphasized that dedicated space for equipment storage, as well as for fabrication and repair of materials used in simulation, is essential to any simulation program and may be underestimated or overlooked in initial design.

Debriefing

Debriefing is a critical component of simulation education and is discussed extensively in Chaps. 6 and 7. For debriefing to be successful, it needs to be timely, focused, task based, and linked to established goals and objectives. The first part of developing a simulation program is identifying the learning objectives, which will be closely linked to the debriefing content. It is important that the faculty debrief to the task/learning objective rather than focusing on the learner being debriefed. In emergency medicine, video-assisted debriefing immediately after the scenario is used frequently. Most often team performances are debriefed with the entire team, and this is especially important in simulations that include a variety of healthcare professionals.

The specific debriefing model varies widely across different programs and with different learners. One common technique is the "Plus/Delta" model (what went well, the Plus vs. what can be improved, the Delta), which is useful for relatively straightforward discussions [63]. The WISER Simulation program uses a model referred to as "GAS" which stands for Gather–Analyze–Summarize. This three-step technique focuses on active listening followed by facilitating learner reflection and analysis of their actions and finally a summary of lessons learned [64]. A third technique is the "Debriefing with Good Judgment" model, which uses an advocacy–inquiry model to assist in the discovery of the participants' "frame" or understanding of the situation that underlies the visible action [65]. This technique is useful to understand more complex individual and team behaviors. Emergency medicine educators have strongly embraced debriefing because of its important role in deliberate practice and the development of mastery skills.

Funding

Simulation programs require substantial initial investments of capital and robust sources of operational funding for both personnel and equipment [66]. To successfully cultivate an array of funding sources, the leadership team should make use of all available resources within an institution. A combination of internal and external funding sources is necessary in many cases. Fortunately, simulation training appeals to a broad audience and tends to easily address the needs and goals of administrators, department chairs, program directors, hospital and university governing boards, governmental granting agencies, private foundations, and individual philanthropists. The concepts of patient safety, healthcare quality, and efficient training and evaluation of providers resonate widely. When it is recognized that funding a simulation center is a "win–win" situation for the institution, the providers', and most importantly the patients', funding tends to follow.

Those in a position to initiate a simulation program will need to advocate for the utility of simulation training and the ability of well-designed programs to serve the needs of the individuals, programs, and the institution. As the center matures, the need to maintain funding will require proof of effectiveness. Robust data collection and tracking will demonstrate that a simulation center can help the institution efficiently meet its requirements from the Joint Commission, American Nurses Credentialing Center (ANCC), and the Accreditation Council for Graduate Medical Education (ACGME) [43, 45, 67–69].

Beyond even these requirements, consistent training and evaluation of providers to maintain skills and improve quality helps to justify financial outlay from administration. Reducing medical errors and improving quality through simulation may lead to a reduction in healthcare delivery costs and even a reduction in medical liability premiums [70]. Additional drivers such as maintenance of board certification make simulation a necessary element in ongoing training and provider evaluation [71]. Simulation funding should be viewed as an investment in quality, efficiency, and safety.

Budget Allocations

An investment in a simulation program pays dividends regardless of the clinical environment. Whether serving a small contract group, a large multihospital group, or an academic program with a residency, budgetary allocations will provide the most consistent source of funding. Centers have been started and even operated for several years with funding from a single large grant, but sustainability relies on consistent funding both for personnel and equipment. It becomes the job of the simulation leadership team to reveal the benefits of simulation and leverage the many drivers to generate budget allocations. As a simulation center develops a consistent source of funding, directors and staff can focus more of their energies on simulation program development and dissemination. Because simulation is increasingly being shown to improve real patient outcomes and even decrease healthcare costs, it has demonstrable value to all those who control operational and capital budgets. Those who control operational budgets often are the same individuals who will benefit from the data generated in a simulation center, helping them to fulfill training, reporting, and accreditation requirements.

Philanthropy

Foundations and individual donors are a critical source of funding for both capital and operational budgets. Capital purchases tend to be more appealing to donors, but the goals of various foundations differ. It takes a firm understanding of the development process to work with potential donors to achieve mutually beneficial goals. This almost always requires that the simulation team work with a skilled and experienced development staff. These individuals can help identify potential donors, prepare presentations, generate publications, and facilitate the donation process. This involves balancing the needs of a simulation center with those of an entire institution, but often the appeal of simulation attracts considerable interest. Smaller groups or those without development personnel may identify donors on their own. A grateful patient or family, a local foundation with a shared mission, or even personal connections can provide fruitful opportunities. It is important to recognize these very important contributions with naming rights, donor recognition displays, publications, and sponsorship materials.

Corporate donors can potentially provide funding through a variety of mechanisms. A company may be interested in providing discounted clinical equipment since it is to their advantage to have their product used by a large audience. They may be willing to rent space to train their sales representatives and healthcare providers, or provide sponsorship for CME programs. Lastly, they may be willing to provide donations outright for naming rights to a simulation space.

Those with a direct stake in simulation training, including current faculty, physicians, and nurses, are often willing to make contributions through a giving campaign. Many programs have alumni funds that are used for education. Alumni easily recognize the importance of quality training opportunities for current trainees. A simulation center provides such tangible benefits. When a donor sees a simulator, a task trainer, or a named simulation room, they know that their money is having a direct impact on training and patient care.

Granting Agencies

Federal agencies largely under Health and Human Services including NIH, HRSA, and AHRQ make specific calls for funding proposals. Writing a federal grant application requires a significant level of experience and sophistication, a task made much easier if a support staff is available. Novice grant writers should seek to develop a track record of peer-reviewed publication and smaller grants before pursuing federal funding. State funding from EMS agencies can be a fruitful place to start, as can specialty-specific granting bodies including the Society for Academic Emergency Medicine and the Emergency Medicine Foundation. Grants targeted not only at simulation but any program that involves patient safety, reduction of medical errors, and healthcare quality improvement may be suitable for simulation-based applications.

Fee Generation

Attempts are being made at some centers to operate on a fee-for-service business model. The success of such a model depends on potential client mix and the ability of these client groups to establish and operate their own programs rather than turning to a third party. Medium to large groups, hospitals, universities, and academic departments have the resources to seek funding in a number of areas, making an investment in creating a simulation program worthwhile. Individual practitioners and small groups may not be able create and operate their own simulation programs, thus are likely to be potential clients of a fee-for-service center. Future market conditions and an increasing desire for courses that incorporate simulation may lead some fee-for-service simulation centers to a greater likelihood of sustainability.

Few centers are currently able to cover all operating expenses with fees alone. For most centers, fee generation from CME and maintenance of certification courses will be most effective if viewed as a way to defray the cost of capital improvements and operations rather than a method to cover all operating costs or generate profits.

Faculty Development in Simulation

Emergency medicine faculty are similar to all simulation educators in that they should be familiar with the advantages and disadvantages of simulation as an educational tool. Simulation will not be effective unless it is used as a well-planned and thoughtful part of the entire curriculum [72]. Faculty time constraints and lack of training were the top two barriers to simulation use in a recent study of emergency medicine simulation users [27, 73]. Faculty members who are interested in providing educational sessions for physicians in residency training must therefore be supported with adequate release time and training. General educational competencies such as objective writing, feedback, and assessment are required skills in simulation [74–76]. All faculty should also be experts in the clinical content area. Finally, the faculty member must develop expertise in simulation-specific skills such as scenario design, debriefing, and some technical knowledge about simulator operation, capabilities, limitations, and programming. These skills can be gained through institutional level training programs or by attending specialty-specific meetings where simulation is a focus. Some examples of these include the AEM Consensus Conference, the Council of Emergency Medicine Program Directors Annual Meeting, or the ACEP Teaching Fellowships and Simulation Courses. Many emergency physicians have also received training at simulation-specific national courses such as the Institute for Medical Simulation at the Center for Medical Simulation or at the International Meeting for Simulation in Healthcare. Simulation skills should be seen as a core competency for emergency medicine faculty along with the more traditional teaching techniques.

Fellowships

With the almost universal use of simulation in emergency medicine training programs [27], there is growing need for educators trained in how to use the teaching method effectively. This has led to rapid growth in non-ACGME approved fellowships in simulation at a variety of simulation centers, many with active ED participation or leadership. As there is no recognizing body or regulation of such fellowships, so their content and focus varies widely. Many include master's degree coursework in adult education or certificates. These fellowships are often conducted at interdisciplinary centers and with interdisciplinary leadership that reflect the composition of their simulation centers which often merge educators from different specialties. Funding can be provided by part-time clinical work, department funds, grants, or institutional budgets [28].

The Society for Academic Emergency Medicine lists six simulation fellowships (http://www.saem.org/fellowship-directory): Alpert Medical School of Brown University, Massachusetts General, St. Luke's-Roosevelt Hospital Center, Stanford University School of Medicine, Summa Akron City Hospital, and University of California, Davis. Each of these fellowships has their own unique strengths and design that are described below. Additional fellowships are being added every year, so this list is meant to provide a sample and is not a comprehensive catalog.

The MGH Fellowship in Medical Simulation in Boston is a tailored program over 1–2 years and includes an established curriculum in the Harvard Macy Institute and the Institute for Medical Simulation. Fellows here run the "On-Demand Medical Education Service" which has been previously published [1, 9]. Certificates in teaching and learning and other advanced certificates are available. Fellows work approximately half time clinically as an EM attending at MGH or an affiliate. The St. Luke's-Roosevelt program is one of the newest fellowships listed at SAEM and is located in New York City. Taking two people per year as about 20 h clinical, it is a 1-year fellowship and is a joint effort with other departments including critical care.

The Stanford University fellowship in California is one of the oldest and most established fellowships. It is a 1-year fellowship with work at four separate simulation centers. Fellows attend in the hospital emergency department. The Summa Akron City fellowship is a 1–2-year program in Akron, Ohio, and accepts up to two fellows per year. Fellows work in several simulation laboratories and attend in the emergency department at one of three local EDs. The University of California, Davis, simulation fellowship is a 1- or 2-year program, and fellows participate both at the center and in local disaster preparedness training. Fellows work part-time as attending physicians in the emergency department at the UC Davis Medical Center. The STRATUS Center for Medical Simulation Brigham and Women's Hospital has a 2-year fellowship that includes matriculation into Harvard Graduate School of Education for a master's degree in education.

Simulation-Based Education

Team Training

High-quality healthcare in essentially all clinical specialties requires a high level of team performance. Nowhere is this more apparent than in emergency medicine where rapid, accurate decision-making and communication must all operate efficiently and effectively to provide optimal care. Errors in communication and inefficiencies in team dynamics can lead to delays, incorrect treatment, and adverse outcomes [77]. By creating a structure to deliberately practice critical team skills in a systematic fashion, dissecting and debriefing all elements of a complex team dynamic, simulation training provides an opportunity that cannot be accomplished easily in a real-world setting.

The principles of team dynamics have evolved largely from other fields, most notably the flight industry. Crew resource management (CRM) principles are widely used in simulator-based exercises for pilots and flight crews [78]. CRM formed the basis for the development of the TeamSTEPPS® program by the Agency for Healthcare Research and Quality, a program that has come into wide usage for healthcare team training [79]. The elements of effective team training include team structure, leadership, situation monitoring, mutual support, and communication. Each of these elements is further subdivided to include key components that can be easily incorporated into simulation scenarios.

It is important to recognize that team training should itself form the simulation case objectives, leading to a delineation of the critical actions and development of evaluation tools. Often, learners will naturally focus on the medical management elements of a case, but when team training is the goal, it becomes the role of the scenario author and director to clearly define the goals, design the scenario to incorporate the critical elements, and focus on these elements in the debriefing.

Robust observation and evaluation tools such as the TeamSTEPPS® performance observation tool, the Behaviorally Anchored Rating Scale (BARS), and Behavioral Assessment Tool (BAT) can be useful adjuncts to scenario design, learner evaluation, and debriefing [79, 80]. Using such tools importantly focuses the objectives on the critical elements of team function.

Assembling the team to perform simulation training can present some challenges. Creating "buy in" and convincing administrators to allocate funds for training requires identifying discipline-specific drivers. Administrators easily recognize the value of simulation training once they become familiar with the ways in which it can help them train and evaluate staff, collect data for reporting requirements (e.g., Joint Commission, ACGME, ANCC), address patient safety goals, and contribute to the reduction of medical errors. Evidence is building in the literature to support these assertions [81]. Additionally, offering CME and CE credit often helps to serve the needs of both the simulation program and individual providers. Building team dynamics and esprit de corps in the real clinical setting has intrinsic value. "If we practice how we play, we play how we practice" resonates with both providers and departmental leaders.

Emergency medicine is uniquely positioned to take advantage of multidisciplinary and multispecialty team training opportunities, interacting with virtually every clinical specialty and often intersecting at the point where well-developed team skills can affect patient outcome. A trauma resuscitation bay, for example, is a nexus of interdisciplinary care requiring physicians, nurses, paramedics, and ancillary staff to function together efficiently and expertly. In the real clinical environment, team members change regularly. A single team with consistent individual members familiar with each other may be elusive. Incorporating standardized team training on a regular basis with all members of a department leads to more clearly defined expectations and greater consistency in care.

In an OR setting, team training has been shown to decrease patient mortality [82]. In the emergency department, team training can be applied to an array of multidisciplinary clinical scenarios. The high-intensity, low-frequency events such as mass casualty situations, pediatric arrest, emergent obstetrical delivery, and neonatal resuscitation all provide an opportunity to bring providers from several specialties and healthcare disciplines together for team training. Beyond the low-frequency events, using simulation to drill the more routine intradepartmental scenarios can improve team dynamics. ST-elevation myocardial infarction, stroke, respiratory distress, status asthmaticus, status epilepticus, and toxicologic emergencies are just some of the contexts within which such team training can take place.

Simulation can be used to develop and troubleshoot new protocols and systems that require a highly efficient team function. "Code STEMI," "Code Stroke," and sepsis response protocols, for instance, incorporate an array of moving parts, personnel, and equipment that must function seamlessly. A change in one or two variables may impact the delivery of essential interventions – door-to-balloon time, door-to-drug, or time-to-antibiotics. Rather than altering variables in the real clinical setting, changing them in a simulated setting can allow examination of their impact and help troubleshoot systems and provide an efficient, safe avenue to explore quality improvement. Team training is an essential part of quality healthcare delivery and patient safety, and simulation programs can clearly impact the many facets of healthcare team dynamics to optimize patient outcomes.

Procedural Training

The use of simulation to train practitioners to perform both routine and rare or high-risk procedures has gained traction among virtually every procedure-based specialty. This approach to training is founded not only on pragmatic considerations of patient safety but also on the concept of skill acquisition through deliberate practice [83–85]. Advanced surgical simulators have been developed for training in endoscopy and laparoscopy and have demonstrated a high degree of transfer of training to the clinical setting [86]. Likewise, obstetric simulators have been linked to improved technical proficiency, self-reported confidence and teamwork, and decreased incidence of complications such as shoulder dystocia [87].

Task trainers have become commercially available for a wide array of emergency department procedures. Products that offer a high degree of physical fidelity appear to be of greatest utility for procedures (e.g., intubation) that require complex motor movements and precise navigation of anatomic structures. Medical students trained on simulators can achieve proficiency with uncomplicated intubation in as little as 75–90 min [88], and clinicians trained on simulators perform equally well on fresh cadavers and live patients [89]. Procedures such as cricothyrotomy and chest tube placement are frequently taught with either commercially available products such as TraumaMan (Simulab Corp., Seattle, WA) or improvised synthetic or tissue-based task trainers. While these techniques are employed widely, the evidence for their efficacy in knowledge transfer to the clinical setting is limited. Additionally, there is sparse and conflicting data as to the comparative effectiveness of commercial task trainers versus tissue-based simulation for invasive procedure training [89, 90].

Psychological fidelity, or the degree to which a simulation incorporates the constituent elements of a targeted task, is of greater importance for skill acquisition than physical fidelity [91]. This is especially true for novice learners and for less complex tasks. Procedure training should emphasize the cognitive and motor elements involved in a given procedural skill and should seek a high degree of physical fidelity only for complex tasks or those performed by experienced users. While commercial task trainers have been designed for many diagnostic and resuscitative procedures encountered in the emergency department, some can be realistically simulated via the creative application of conventional materials. Task trainers for cricothyrotomy, venous cutdown, and chest tube placement, among others, can be performed using a combination of conventional medical equipment and either simulated or actual (animal or cadaver) tissue (Figs. 20.4 and 20.5). Given the high cost of many commercial task trainers, these creative solutions provide an appealing option for training in basic procedures. A number of procedure-based simulation curricula have been designed for healthcare providers at all levels of training. Those seeking curricula targeted towards a specific procedure (e.g., lumbar puncture) or learner group (e.g., medical students) often face the question of whether curricula already exist and have been used successfully by other institutions. While there is currently no comprehensive resource for simulation curricula, a number of useful resources do exist. MedEdPORTAL (www.mededportal.org), an online, peer-reviewed educational resource created by the AAMC, is widely used for the dissemination of simulation curricula. For emergency medicine-specific content, the Council of Emergency Medicine Residency Directors (CORD-EM), along with the Simulation Academy of the Society for Academic Emergency Medicine (SAEM), has created an online bank of peer-reviewed simulation cases which is discussed above. Both resources are available to simulation educators free of charge.

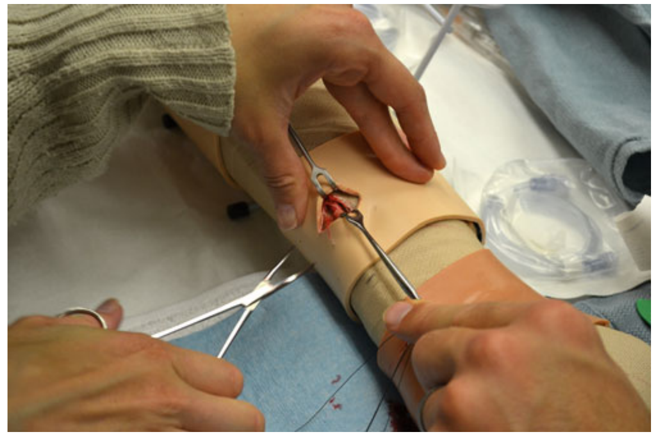

Fig. 20.4 Venous cutdown simulation

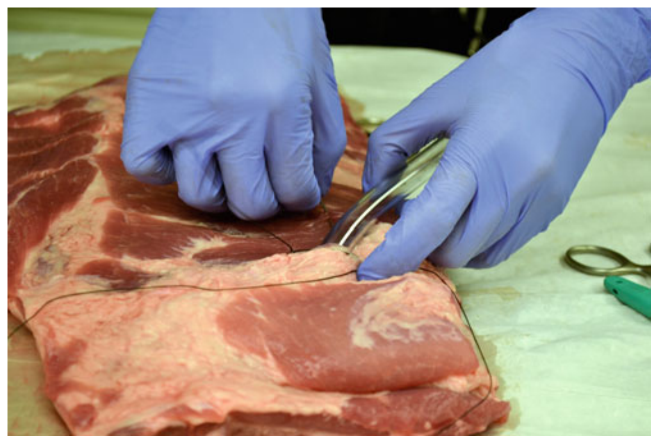

Fig. 20.5 Chest tube simulation

Integrated Simulation Curriculum

When selecting or designing a simulation curriculum, attention should be paid to the specific goals and objectives of the simulation experience, the training and experience level of the target audience, and the number of contact hours required to complete the curriculum. Table 20.2 demonstrates one sample of a curriculum which is designed as a 1-year introduction to core procedures for PGY I emergency medicine residents. The curriculum takes place over ten sessions of 2 h each, and each session includes reading material, a pretest, and hands-on practice in the simulation lab. The sessions are taught in small groups with only the PGY-1 residents present. The other residents participate in their own level-specific training during the same time.

Procedure training is a cornerstone of emergency medicine simulation, and those seeking to incorporate it into their training programs should not feel constrained by lack of funding or access to commercially available task trainers. Successful curricula for the vast majority of clinical procedures can be created by emphasizing the psychological fidelity of the experience to the procedure being taught,

Table 20.2 Sample procedure curriculum

Session number	Core procedures	Location
#1 – August	1. Regional blocks 2. Arterial line 3. Lumbar puncture	Simulation lab
#2 – September	1. CT interpretation 2. Central venous line placement 3. Ultrasound	Simulation lab
#3 – October	1. Slit lamp exam 2. Rust ring removal 3. Tono-pen use 4. Nasal packing 5. I+D of auricular hematoma 6. Foreign body removal	Simulation lab and in situ simulation in emergency department
#4 – November	1. Thoracentesis 2. Pericardiocentesis 3. Transvenous pacing	Simulation lab
#5 – December	1. Orthopedic reductions 2. Splinting 3. Extremity radiology	In situ simulation in emergency department
#6 – January	1. Fiber-optic laryngoscopy 2. Awake intubation 3. Difficult airways	Simulation lab and in situ simulation in emergency department
#7 – February	1. Communication skills lab 2. Ultrasound	Simulation lab
# 8 – March	1. Normal delivery 2. Complicated delivery 3. C-section 4. Third trimester bleeding	Simulation lab
#9 – April 18	1. Communication skills lab 2. Palliative care	Simulation lab
#10 – June	1. Leadership in critical care 2. Medical and trauma resuscitation	Simulation lab and in situ simulation in emergency department

having clearly defined goals and objectives for learners, and understanding the baseline experience level of trainees.

Conclusion

The use of simulation-based education and assessment is robust in emergency medicine for medical students and housestaff. It is a matter of time when faculty level education and assessment will catch up as simulation is engrained in the fabric of emergency medicine education, assessment and maintenace of certification, during the last decade emergency medicine has been at the forefront of simulation and is poised to be leaders of the field in the future.

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