Internal Medicine Grand Rounds

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Simulation-Based Education in Internal Medicine

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This is to acknowledge that Hetal J. Patel, M.D. has disclosed that she does not have any financial interests or other relationships with commercial concerns related directly or indirectly to this program. Dr. Patel will not be discussing off-label uses in her presentation.

Biosketch:

Dr. Patel is an Assistant Professor in the division of Pulmonary and Critical Care. She serves as the Associate Fellowship Director, Director of Chest Medicine Clinic at Parkland Hospital, and Co-Director of the Internal Medicine Simulation Program. She completed her undergraduate training at Texas A&M University. Since then, she has been a UT Southwestern "lifer" graduating from UT Southwestern Medical School in 2004. She also completed her Internal Medicine residency and Pulmonary and Critical Care fellowship here and has been on the faculty since 2010. Her interests are medical education and simulation.

Purpose and Overview:

The goal of this presentation is to discuss changes in medical education leading to potential roles for simulation-based education. In addition, the history of simulation, data within internal medicine programs, and resources needed to establish such a program will be discusses. Finally, an overview of the current UT Southwestern Internal Medicine Simulation Program and future visions will be presented.

Objectives:

1. Understand the shift in medical education to focus on outcomes.
2. Understand the history of medical simulation and use within internal medicine.
3. Understand the current UT Southwestern Internal Medicine Simulation Program.

In the last 15 years, medical education has faced fundamental challenges and opportunities for innovation due to the shifting paradigm now focusing on outcomes. In 1999, the Institute of Medicine released *To Err is Human* noting the high frequency of medical errors and calling for emphasis on patient safety and improved training to prevent common types of errors [1]. Shortly thereafter, the Accreditation Council for Graduate Medical Education (ACGME) defined the six core competencies to establish the goals of residency training [2]. In 2003, the first work hour restrictions were set. In the last 2 years, work hour limitations and patient encounter caps have significantly altered the traditional medical education model. The summative effect of these changes includes fewer patient encounters hindering not only the frequency of common patient interactions, but also the likelihood that all trainees will have the same "total" experience. Added to that are the increased constraints on faculty teaching time, global shift to outpatient medicine, and increased emphasis on patient outcomes. While these changes lead to challenges in creating curricula, institutions struggle to provide excellent educational experiences while prioritizing patient safety.

At many universities, simulation-based medical education has been integrated as a teaching tool to bridge the gap. Simulation-based medical education (SBME) is an instructional technique that substitutes real patient encounters replicating the substantial aspects of real world situations. The earliest simulator is the standardized patient, still widely used as an educational and assessment tool. SBME technology, or simulators, includes task trainers, computer enhanced mannequins, computer based scenarios, and virtual reality. In fact, SBME has now become a core program requirement by ACGME [2] and is strongly recommended by the ABIM for all internal medicine trainees[3].

A Brief History of Medical Education

Even in the earliest days of Ayurveda in 500BC, the predominant teaching style for those who wished to pursue medicine was the apprenticeship model. Young men were to study medicine from a "good teacher," one "whose precepts are sound, whose practical skill is widely approved, who is clever, dexterous, upright, and blameless; one who knows also how to use his hands, has the requisite instruments and all his senses about him, is confident with simple cases and sure of his treatment in those which are difficult; of genuine learning, unaffected, not morose or passionate, and who is likewise patient and kind to his pupils"[4]. Great teacher physicians were described in other Eastern and Middle Eastern cultures as well[4]. Even in North America, the traditional medical doctor path, requiring a university-based education consisting of two years of preclinical teaching and two years of practical experience was not defined until Flexner's report was released in 1910. One of his findings described the lax apprenticeship model of training at most American medical schools leading to significant variability in medical education. The high standards demanded after the release of his findings led to closure of about one third of American medical schools in the early 1900's. Since then, basic science and the advancement of healthcare have driven educational curricula [5]. In the 1970's, reform calling for competency-based training began gaining popularity due to advancement in educational theory[6]. Ultimately, in 1999, the ACGME outcomes project described the official transition in graduate medical education to a competency-based model. Achievement of the six core competencies (patient care, medical knowledge, professionalism, practice-based learning and improvement, interpersonal and communication skills, systems-based practice) defined by the ACGME in 2000 is now at the heart of graduate medical education. These are universal across all specialties [6].

In 2013, the Next Accreditation System (NAS) was implemented that further identified unique milestones for each specialty. Internal medicine has 22 milestones or "subcompetencies". The goal of these milestones is to measure a resident's level of competency and, through reports via NAS, a program's educational effectiveness [7]. The new evaluation system is based on the five levels of competency described by the Dreyfus model of skill acquisition distinguishing levels from novice to expert. An early trainee, for example an intern, should start at the beginner or novice level and transition through the levels to at least proficient, and maybe even expert, by the end of training [8].

In professional domains such as medicine, to acquire the skills needed for proficiency, the concepts of deliberate practice and mastery learning are applied. Deliberate practice is a process of skill and knowledge acquisition to reconcile the many years of full time engagement ideally required to reach high levels of performance[9]. To achieve deliberate practice, the learner must be highly motivated. In regards to the task, the learning objective should be well defined and at the appropriate level of difficulty. The learner must have a chance at focused, informative feedback. Finally, the learner should the provided with opportunity for repetition to continue to improve his/her performance[10].

Mastery learning is closely related to deliberate practice as an approach to competency-based education. In mastery learning, a level of proficiency must be obtained by the learner. All learners should accomplish all educational goals. It has the features of a clear baseline, engagement in an educational experience, and then achievement of a minimal passing standard[10-12].

To achieve the competencies, various educational tools including patient experiences, self study, didactic lectures, and scholarly activities can be used. However, these are not all forms of active learning. SBME can complement patient care, and is an effective form of learning for later recall. In Edgar Dale's famous "Cone of Learning," it is second only to the real experience [13]. In has been noted that ACLS skills acquired during SBME are still present 6 to 14 months after the education [14].

Finally, the ACGME now describes assessment tools to evaluate residents in the context of milestones and competencies. This "tool box" has many components including evaluations from faculty and patients, event logs, direct observation, and simulation. In relation to the milestones, SBME can be implemented not only for skill and knowledge acquisition but also as an assessment tool [7].

A Brief History of Simulation

Non-medical fields such as aviation and the military have embraced simulation-based education. Edwin Link created the first "blue box" flight simulator in the 1920's and opened his school in 1930. In 1934, the military purchased his Link trainers and began training fighter pilots via simulation. In the 1960's, the National Aeronautics and Space Administration created and used Apollo simulators and eventually used simulation for Skylab 2 repairs. In the 1970s, the first full flight simulator was born using digital computer imaging, and by the 1980's, the FAA mandated that simulation be used to evaluate pilots. Until the 1990's, the military accounted for the majority of simulation innovation and creation in North America. Interestingly, the gaming industry then surpassed the military in resolution graphics with realism, and now gaming software is even used for preflight training[15]. It should be noted that both the aviation industry and military did not initially embrace simulation technology. This brief description illustrates the timeline needed to create, advance, and accept simulation education as the standard in other professional fields.

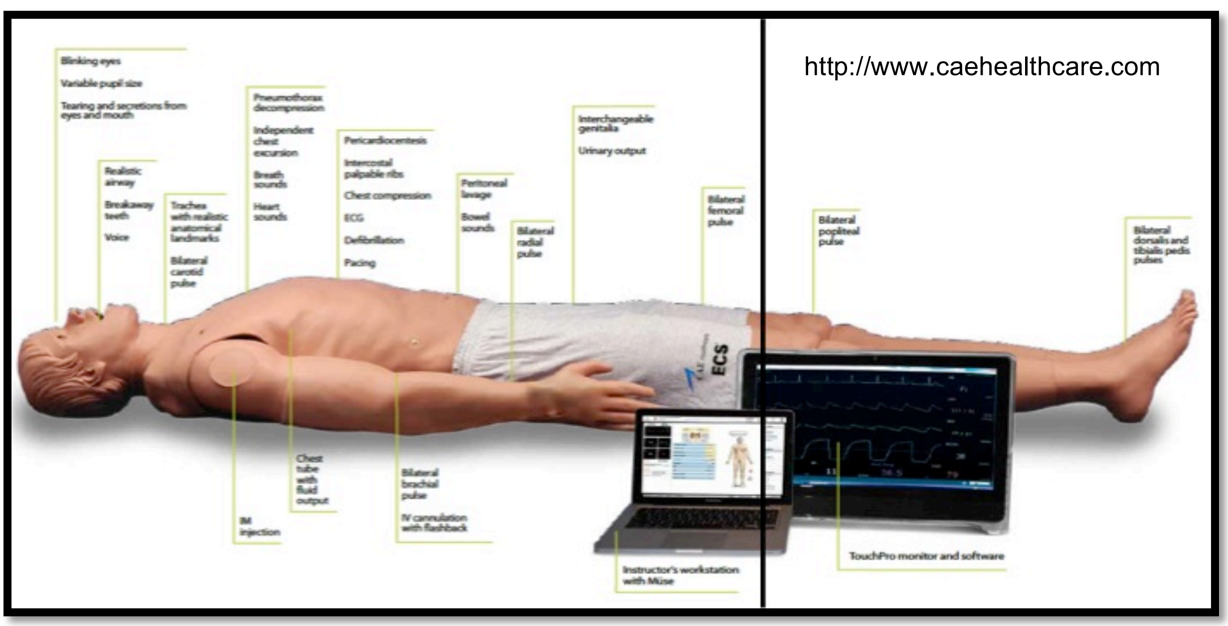
The first medical mannequin, Rususci-Anne, was developed by Dr. Bjorn Lind and a toy maker, Asmund Laerdel, primarily for CPR training. She was used for mouth-to-mouth breathing and for chest compression training. In the 1960's Dr. Stephen Abrahamson and Dr. Judson Denson created the first computer-controlled simulator. This simulator was lifelike and had a chest that moved, eyes that blinked, and a jaw that opened and closed. However, it did not see great success and only one was created. Also in the 1960's, Harvey, the first cardiology simulator was developed at University of Miami by Dr. Michael Gordon. Harvey was able to demonstrate 27 different cardiac conditions and is still widely used in an advanced form. Finally, it wasn't until the 1980's, that a realistic patient simulator was created at Stanford by a team led by Dr. David Gaba. By placing this lifelike mannequin in a real operating room surrounded by equipment, the learner was submerged in the scenario and high fidelity medical simulation was born[16].

Types of Simulators

Simulators can be categorized into five major groups: standardized patients, computer - based programs, virtual reality, task trainers, and computer enhanced mannequins. Briefly, the "standardized patient" is widely used for education in medical schools and was adopted for the teaching of normal pelvic exams in 1968. Standardized patients are used for assessment in Observed Structured Clinical Exams in the majority of medical schools and to evaluate all US medical graduates for licensure during the USMLE Step II Clinical Skills Exam[15]. Software-based simulation are computer based programs that create active scenarios that can change based on learner interventions via a computer screen. *Advanced Cardiac Life Support Heartcode*, by the American Heart Association, is an example of widely used computer-based simulation. Virtual reality provides 3-dimensional immersive environments to provide visual and auditory experiences. Virtual reality has been used in bronchoscopy training with improved dexterity in novice learners trained with simulation [17].

Partial task trainers consist of 3-D representations of body parts/regions with functional anatomy for teaching and evaluating particular skills. The user interface is mostly passive meaning the device is examined or procedures are performed on it [18]. A task trainer is the appropriate simulator when the goal is to practice a psychomotor skill in isolation or to practice one specific task.

Computer enhanced mannequins (CEM) allow for high-fidelity simulation when coupled with realistic environments and healthcare teams. These simulators can recreate physical exam findings, normal and abnormal heart and lung sounds, and allow for a number of interventions. In addition, they provide realistic interaction by accurately responding to clinical responses. A CEM can have a range of realistic findings including the ability to blink his eyes, have convulsions, breathe physiologically or manually, and "speak" to the learners. He has a realistic airway with a flexible tongue, vocal cords, epiglottis, vellecula, arytenoid cartilage, and trachea. He can be intubated or have a cricothyrotomy performed. Procedures can be performed such as chest tube placement or pericardiocentesis with appropriate physiological changes given the success or lack of success of the procedure.



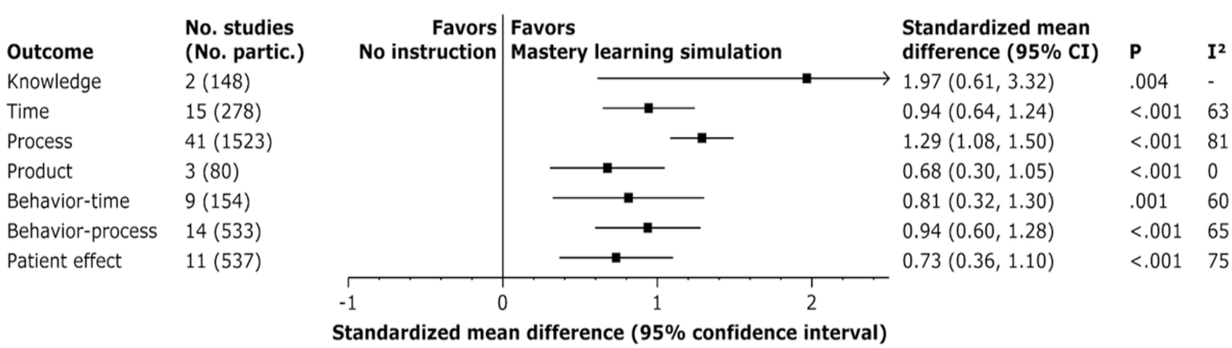
Traditionally, CEMs are controlled via a computer program that has predetermined scenarios preloaded. These can be programmed to follow an "if this, then that" algorithm to anticipate the learners interventions and response of the "patient." A wireless CEM that can be controlled from a remote area is also now available on the market.

Does SBME improve outcomes?

The number of publications evaluating the effectiveness of SBME has exploded in the last decade. In both the fields of anesthesia and surgery, SBME is used widely. Anesthesia data suggests that SBME improves clinical decision-making and team competence while surgical data supports skills development specifically in laparoscopic and endoscopic procedures[19]. When distinctively addressing simulation-based education in internal medicine, fewer data are available and the methods and endpoints vary widely. Several studies using deliberate practice and mastery learning, as well as those addressing patient outcomes will be discussed here in further detail.

McGahie, et al identified over 3700 articles between1990 to 2010 and included 14 in a meta-analysis of publications that utilized deliberate practice and compared SBME "head to head" with traditional teaching. These included a wide variety of skills including central line placement, ACLS, thoracentesis, and laparoscopic skills. Of the 633 learners, 389 were internal medicine trainees. They found that SBME was superior for the acquisition of the above skills[20].

In a meta-analysis looking at all health professions, Cook et al, found that 82 studies compared mastery SBME with no intervention. They found that SBME with mastery learning was associated with large effects on skill and moderate effects on patient outcomes. Even when SBME was compared to other types of instruction, the simulation instruction was favored. Furthermore, when comparing studies that used SBME with mastery to those without mastery learning, the mastery model was favored[12].



Cook, D.A., et al., *Mastery learning for health professionals using technology-enhanced simulation: a systematic review and meta-analysis.* Acad Med, 2013. **88**(8): p. 1178-86

Wayne, et al at Northwestern University in Chicago, identified one example of procedural competency amongst internal medicine residents using SBME. They enrolled 40 internal medicine residents in an intervention to gain thoracentesis skills. Mastery learning was evidenced by a minimum passing score on a written and clinical skills exam. The residents took an initial pre-test, followed by a standardized didactic and training on a thoracentesis task trainer in two 2-hour sessions. They were subsequently tested 4-6 weeks later. No trainees met the minimum passing score prior to the intervention. 37 residents met the minimum passing score after one time through the intervention. 3 residents required more time but then met the minimum passing score. The mean score on the clinical skills exam had a 71% gain, which was highly significant. In addition, they found that those residents that required extra time to achieve mastery had an initial posttest clinical skills score that was 20% less than others [21].

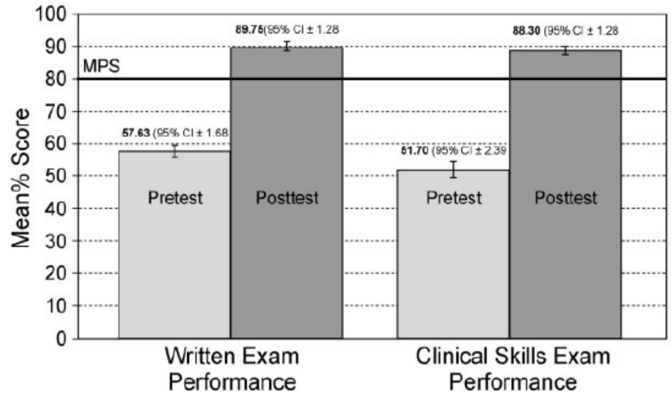


FIGURE 1. Performance on thoracentesis written exam and clinical skills exam performance (MPS, minimum passing score).

Wayne, D.B., et al., *Mastery learning of thoracentesis skills by internal medicine residents using simulation technology and deliberate practice.* J Hosp Med, 2008.

Similarly, here at UT Southwestern Medical Center, in 2008, 31 interns participated in an optional thoracentesis curriculum. The group underwent a written pretest, 2 hour didactic and hands on simulation intervention, followed by a posttest. During the intervention, interns were asked to demonstrate proficiency with the task trainer. The improvement in posttest scores was statistically significant. Learner feedback was very positive and participants reported improved confidence [22].

While the acquisition of procedural skills via SBME seems intuitive, it has been noted that clinical decision-making can also be enhanced through SBME. In 2008, Wayne, et al published a case-control study about cardiac arrest responses. The intervention arm included all second year residents who underwent four 2-hour simulations sessions and completed 1 hour of pre and post-testing. The four sessions included procedures, pulseless arrhythmias, tachyarhythmias, and bradycardias. The control group consisted of third year residents who had undergone traditional teaching. Through a 6-month window, all code blue calls were reviewed.

Table 1—*Descriptive Statistics for 48 ACLS Events**

Variables	Simulator-Trained Residents	Traditionally Trained Residents	p Value
Mean patient age, yr	67.1 (SD, 12.8)	66.9 (SD, 13.9)	0.97
Receiving ventilation	2 (10)	7 (25)	0.45
Receiving telemetry	9 (45)	11 (39.3)	0.69
Adherent to resuscitation (≥ 75% correct)	13 (65.0)	6 (21.4)	0.002
Survived event	9 (45.0)	13 (46.4)	0.92
Mean postevent survival to death or hospital discharge, h	194.7 (SD, 141.2)	107.1 (SD, 105.8)	0.11
Survived to hospital discharge	2 (10)	1 (3.6)	0.36

*Data are presented as No. (%) unless otherwise indicated.

Wayne, D.B., et al., *Simulation-based education improves quality of care during cardiac arrest team responses at an academic teaching hospital: a case-control study.* Chest, 2008. **133**(1): p. 56-61.

While no difference was seen in patient outcomes, there was a statistically significant difference in adherence to AHA guidelines, despite the fact that all of the third year residents had recently repeated their ACLS certification. This study highlights a way to measure competency based outcomes that are not necessarily tied to patient outcomes [14].

As more programs are developed to improve clinical decision-making, the difficulty to identify a valid study endpoint remains. Recently, a SBME program at Massachusetts General Hospital was piloted to introduce clinical decision making to interns. 36 interns voluntarily participated in the sessions. The sessions were one hour each, consisted of two 15-minute cases with subsequent debriefing, and were facilitated by simulation faculty and residents. The cases were common internal medicine diagnoses including COPD, atrial fibrillation, CHF, hypertensive emergency, GI bleeding, ACS, alcohol withdrawal, and cardiac tamponade. The learners were asked to complete a survey in the first week of the month following the sessions that they attended. They felt that the program was effective and that the program improved their ability to generate a differential diagnosis and plan. Given the overwhelmingly positive reception of this program, it was added to the required curriculum for all interns the following year [23].

Most data measuring patient outcomes involve central venous catheter placement. These range from the measurement of all complications to reduction in catheter related blood stream infections (CRBSI). Madenci, et al performed a systematic review on all central venous access simulation publications and analyzed randomized controlled trials that used real patient outcomes as the endpoint. They found that procedure success was more likely in the simulation group. In addition, there was a statistically significant difference in the number of passes required between the groups[24].

Similarly, Barsuk, et al noted a statistically significant difference in arterial punctures and the number of passes when using SBME with mastery learning to train internal medicine residents[25]. Furthermore, he designed a study to determine if SBME in central venous catheter placement could reduce CRBSIs. Simulation trained residents took a baseline test, participated in a two hour teaching session, and a three hour opportunity for deliberate practice on the task trainer. The group showed proficiency by obtaining a minimum passing standard on a 27-item clinical skills checklist. The traditional group had previously attended a lecture series on bedside procedures but did not have simulation practice. Of note, central venous catheter bundles were used throughout the study in all intensive care units and required full sterile technique. Data were collected for 32 months. They found that in the 16 months period post intervention, there was a greater than 80% reduction in CRBSIs, down to 0.5 per 1000 catheter days in the medical intensive care unit.

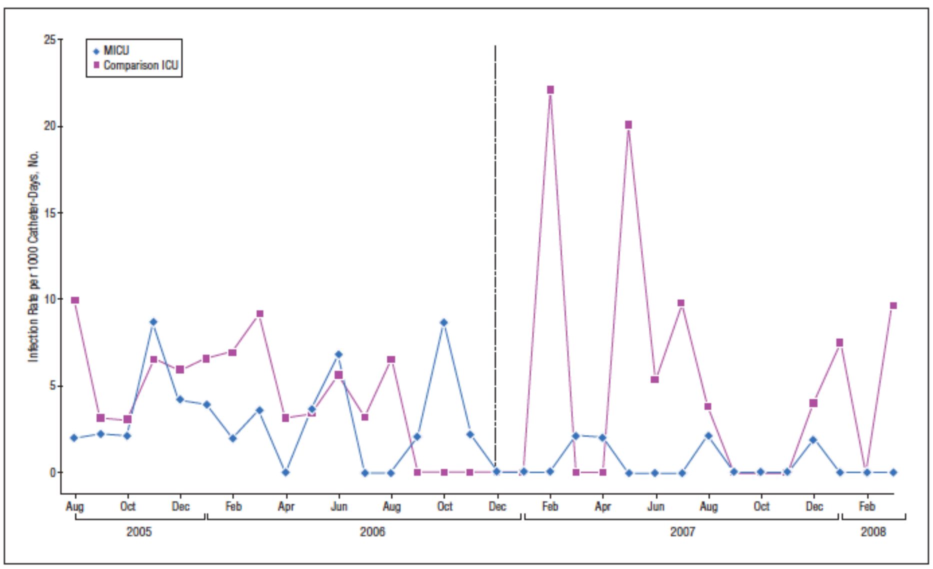
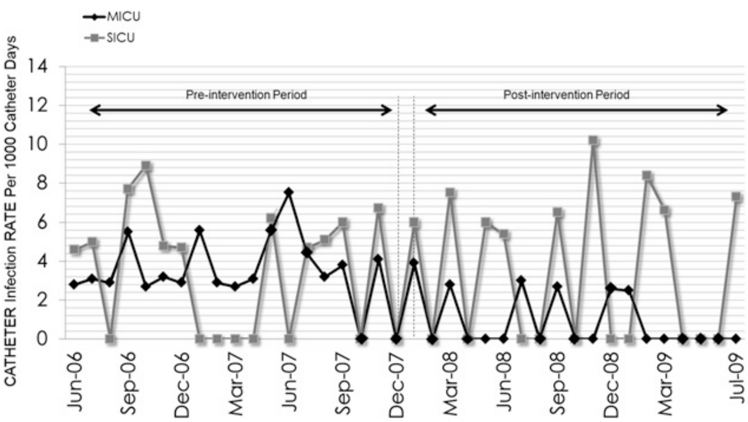


Figure 2. Monthly catheter-related bloodstream infection rates in a medical intensive care unit (MICU) and a comparison intensive care unit (ICU) before and after a simulation-based educational intervention in the MICU. The vertical line at December 2006 indicates the time that simulator-trained residents entered the MICU.

Barsuk, J.H., et al., *Use of simulation-based education to reduce catheter-related bloodstream infections.* Arch Intern Med, 2009. **169**(15): p. 1420

Data collection was performed by hospital personnel who were completely independent of the study. Residents were aware that complications such as arterial puncture and pneumothorax were being collected but were unaware that CRBSI rates were being studied[26]. Cohen et al, analyzed cost savings based on these data. Over the year, it was estimated that 9.95 CRBSIs were prevented. Using linear regression, they estimated $82,000, 13.8 additional hospital days, and 12.2 addition ICU days per CRBSI. The cost of training 69 residents with SBME was calculated approximately $111,000. The cost savings was estimated at greater than $700,000 [27].



Khouli, H., et al., Performance of medical residents in sterile techniques during central vein catheterization: randomized trial of efficacy of simulation-based training. Chest, 2011. **139**(1): p. 80-7.

Interestingly, Khouli et al, similarly used SBME to evaluate reduction in CRBSI. However, his intervention did not include central venous access education, but rather sterile technique education. Residents underwent baseline clinical skills testing in sterile technique. In the intervention, the residents were video taped and were allowed direct feedback. They found a 70% reduction in CRBSI post intervention to 1 per 1000 catheter days. Subsequently, a sterile technique simulation education curriculum was introduced for all rotators in the MICU [28].

In summary, multiple single-center studies and meta-analyses suggest that SBME can improve procedural skill acquisition, learner outcomes, and even some patient outcomes. Moreover, effective simulation programs have key "best practices" important to successful implementation [10, 29, 30]:

1. Feedback – A variety of modalities can be used including immediate facilitator feedback or self-monitoring via video.
2. Deliberate Practice that is learner centered.
3. Curriculum Integration – SBME should be fully integrated and required. It should be carried out in the context of a wider medical curriculum. It cannot replace training grounded in real patient care.
4. Mastery learning – All learners should reach a high educational goal. Education is not time limited.
5. Outcomes – Learners are more likely to master a skill if the outcome is clearly defined.
6. Simulator fidelity
7. Repetitive practice – There is a "dose-response" relationship to improving learner outcomes [31]
8. Clinical Variation – SBME should complement real patient care by providing a variety of scenarios.
9. Transfer to practice
10. Team training
11. Instructor training – "Clinical experience is not a proxy for simulator instructor effectiveness."[10]

Once successfully created and integrated, SBME in internal medicine can be used not only as an educational tool, but also for continuing medical education and assessment. When thinking back to the "tool box" for assessment provided by the ACGME, assessment methods are graded in terms of quality. Class 1 is applied to methods recommended as a core component of a program's evaluation system. There are no assessment tools currently in this class. Class 2 methods "can be considered" and Class 3 "can be provisionally used" as assessment methods. SBME is reliable, valid, and easy to use and interpret, while, at the same time, standardizes learner experiences and clinical variability. If milestone subcompetencies and expected proficiency levels can be integrated into simulation scenario objectives, SBME can become an ideal tool for assessment [7].

UT Southwestern Internal Medicine Simulation Program

The Simulation program in internal medicine, co-directed by Dr. Won Lee, Dr. Melanie Sulistio, and myself, had its debut as a pilot program in 2009, mainly under the guidance of Dr. Won Lee in conjunction with Dr. Todd Hoopman and Dr. Carol Croft. Since then over 300 residents have been educated through the program. At its infancy, the program goals were to educate the house staff on procedures and ACLS. Since then, there have been numerous advancements and improvements to the program with the current integrated curriculum below:

- July PGY1
  - Procedure training with task trainers: Paracentesis, Thoracentesis, Lumbar Puncture, Ultrasound-guided Internal Jugular Central Venous Access, Sterile Technique
  - Basic rhythm recognition, Chest compressions, Basic Airway
- May-June PGY1
  - High Fidelity Simulation - ACLS scenarios
- May-June PGY2
  - High Fidelity Simulation - Clinical Diagnosis and Critical Thinking
    - Ventilator troubleshooting
    - Recognition, characterization, and management of shock
    - Airway emergencies
    - Hypertensive emergencies
- July- December PGY3
  - 8-10 resident experts recognized
  - Promoted to instructor to teach PGY1 and PGY2 May-June course

All residents undergo pretesting and posttesting at each stage. For example, the PGY1 residents are scheduled for two half days of simulation during their first outpatient week of residency. On the first day, all residents take a pretest and watch the New England Journal of Medicine videos on the above-mentioned procedures. Subsequently, they split into small groups (1-2 residents) and rotate through procedure stations. One hour is allotted for central venous access given the added ultrasound training while 30 minutes are allotted for the other procedure stations. In addition to procedures, there are also "code blue basics" and "rhythm recognition" stations. The latter is allotted one hour and allows the residents to identify tachyarrhythmias, bradycardias, and discuss management. At the end of the second session, all interns participate in a blinded written post-test. At the end of their intern year, the house staff return for high fidelity simulation, again during an outpatient week, for one half day. The 4-5 intern groups are called to the simulation lab as if they were an acute care team and asked to assess the patient. The instructors serve as actors within the scenario and observers behind a closed room with one-way window. The CEM is programmed to follow an algorithm, though with the help of Rahm Heymann, our simulation technology specialist, the cases can be altered in real time. Four cases are covered with direct feedback after each case. Video monitoring is conducted via four cameras throughout the room and reviewed by all participants after the first case.

The second year curriculum was first introduced during the 2012-2013 academic year and has been well received. While these scenarios can progress to cardiac arrest if the correct intervention is not started, the educational goal is not ACLS, but rather clinical decision-making in acute care scenarios. The residents are called to the lab as an acute care team and asked to assess the patient. For example, for the ventilator cases, the CEM is intubated and attached to a real ventilator, which is then attached to a mechanical lung hidden behind a curtain. Compliance and resistance can be altered on the mechanical lung to create appropriate changes on the ventilator as the trainees make adjustments to the ventilator or interventions to the patient. Again, the instructors rotate as actors and observers. The mannequin's outcome is realistically changed as interventions are made. Debriefing occurs after each case allows for direct, immediate feedback.

July 2009-June 2010:	37 residents (ACLS) and 68 residents (procedures) longitudinal monthly curriculum
July 2010-June 2011:	49 residents (ACLS) and 50 residents (procedures) longitudinal monthly curriculum
July 2011-June 2012:	49 residents (ACLS) and 49 residents (procedures)
July 2012:	67 interns (ACLS) and 67 interns (procedures)
May 2013:	48 residents (Critical Thinking) and 55 interns (ACLS)
July 2013:	70 interns (ACLS) and 70 interns (procedures)
May 2014:	48 residents (Critical Thinking) and 51 interns (ACLS)

In total, there are 40 half-day sessions in one academic year requiring 3-5 instructors during high fidelity simulation and 6 instructors per session for procedure training. Presently, the organizers and educators are all participating on a voluntary basis. These include faculty, fellows, chief residents, and "expert" residents. Each high fidelity simulation session has a faculty team leader, chosen from the co-directors or key simulation faculty. In addition, at least one additional faculty or chief resident or fellow is present. Finally, at least one expert resident is assigned to each high fidelity simulation session.

<u>Our Simulators:</u>
CAE ECS mannequin
Thoracentesis model
4 Central line models
2 LP models
1 Paracentesis insert
2 Airway models
"Teaching" defibrillator

Equipment costs can vary depending on the complexity of the trainer. Our task trainers, which cost in a range of $300-$3500, have been purchased on a case-by-case basis. Our simulation lab facility is at the medical school and run by a simulation technology specialist. CEMs can range from $40,000 to $100,000. Our CEM is the Emergency Care Simulator from CAE Healthcare and costs near $60,000. All of the simulators have upkeep costs such as skin replacement after continued use. Finally, procedure kits have been obtained from both University Hospital and Parkland Hospital through central supply when those kits are no longer usable for patient care.

Since the inception of the program, learner feedback has been exceptional. Trainees' comments on post session questionnaires indicated that they feel more confident after simulation sessions. In regards to procedures, they comment that being able to familiarize themselves with the kits, learn without the pressure of the patient, and have access to experts truly enhances their learning. Furthermore, they feel that the high fidelity cases are realistic and valuable. The PGY1 responses highly regard the chance to be a "code leader" in a safe environment. The PGY2 comments ask for more cases, both in frequency and quantity.

The initial well reception of SBME in internal medicine has led some medicine subspecialties to start using SBME to initially assess and train fellows. The nephrology division has trained fellows on central venous access using SBME with a mastery learning approach using a clinical skills checklist. The Pulmonary division has used SBME for both fellow training and continuing medical education. Recently, we conducted an educational session for ultrasound guided IJ placement for many of our faculty who trained prior to the use of ultrasound guidance. The session was well received and attended. The trainees reported that after the session, they felt better prepared to supervise residents and obtain central venous access if needed.

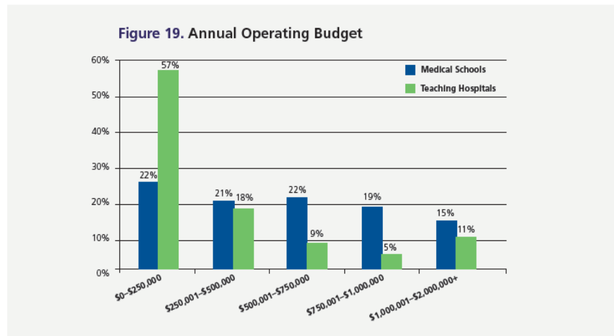
Future Plans

In its current form, our program includes many but not all of the best practices identified for an effective simulation program. Our program design is centered on deliberate practice. We provide immediate feedback, clear outcomes, and clinical variation, and the program is integrated into a broader curriculum. Team training is an important educational goal emphasized during the PGY1 cases. In the future, we hope to better incorporate mastery learning, repetitive practice, and improve instructor numbers and training. Ideally, our goals are to further expand the program by verifying procedural proficiency through clinical skills testing at the start of the second year of residency. By doing this and requiring a minimum passing score, we will apply mastery learning to the procedural skill acquisition objectives of the program. Preferably, residents should have the opportunity for point of care simulation, allowing them to practice procedural skills and run case scenarios prior to and while on their intensive care rotations. To achieve this, we will have to secure both space and time in a simulation lab with more direct access for Internal Medicine residents. To grow the program in such a way, more faculty and fellow instructors will be needed and further education through faculty development will be vital. Program expansion will come with costs, not only in the form of dollars, but also faculty teaching time and learner participation time. At very successful SBME programs, an institutional collaboration allows for pooling of resources. A 2011 survey of medical schools and teaching hospitals showed a wide range of annual operating costs, including staff, equipment, upkeep, and physical location of the simulation lab. At many institutions, these costs were shared by medical schools, teaching hospitals, and various other sources, such as grants [32].

Table 10. Overall Staffing	
Medical schools	Count of responding schools: 70
	Median: 5
	Average: 8.1
Teaching hospitals	Count of responding hospitals: 50
	Median: 2
	Average: 3.4

Participants were asked to report the number of unique people, total FTEs paid through the simulation program budget, and total FTEs supported externally (e.g., by a department) based on the positions most closely affiliated with simulation activities. The total respondents for each category are listed in Tables 11 and 12. Descriptions of each position may be found in Appendix A.

Annual Operating Expenses



Passiment, M.S., H. Huang, G. *Medical Simulation in Medical Education: Results of an AAMC Survey*

In summary, SBME is an educational technology that can enhance and complement the real patient encounter. The American Association of Medical Colleges comments “Simulation is arguably the most prominent innovation in medical education over the past 15 years [32].” It has gained widespread acceptance for clinical skills acquisition and is required for all graduating surgery residents. While data measuring patient outcomes are limited, learner outcomes and competency are likely a more appropriate endpoint. The “see one, do one, teach one” philosophy is no longer accepted, and simulation-based medical education can rise to the challenge of providing excellent education without compromising patient care. With these goals in mind, the Internal Medicine Simulation Program has trained over 300 residents and will continue to strive for optimal educational experiences to augment our already outstanding residency program.

Co-Directors:
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Simulation Technology Specialist:
Rahm Heymann

Key Faculty/Fellows:
Rosechelle Ruggiero, Chad Newton, Pritam Ghosh

Pulmonary Faculty/Fellows:
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Jessica Mullins, Matt Pattillo,
Cayce Brumley, Sachin Gupta,
Kiran Ubhayakar, Shelby Sutton,
Deepa Raghavan, Megan Devine,
Eddy Vadia, Matt Leveno

GI Faculty/Fellows:
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