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ORIGINAL CONTRIBUTION

Procedural task trainer gaps in emergency medicine: A rift in the simulation universe

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Abstract

Objectives: We identified and quantified the gap between emergency medicine (EM) procedures currently taught using simulation versus those that educators would teach if they had better procedural task trainers. Additionally, we endeavored to describe which procedures were taught using homemade models and the barriers to creation and use of additional homemade models.

Methods: Using a modified Delphi process, we developed a survey and distributed it to a convenience sample of EM simulationists via the Society for Academic Emergency Medicine Simulation Academy listserv. Survey items asked participants to identify procedures they thought should be taught using simulation ("most important"), do teach using simulation ("most frequent"), would teach if a simulator or model were available ("most needed"), and do teach using simulation with "homemade" models ("most frequent homemade").

Results: Thirty-seven surveys were completed. The majority of respondents worked at academic medical centers and were involved in simulation-based education for at least 6 years. Three procedures ranked highly in overall teaching importance and currently taught categories. We identified four procedures that ranked highly as both important techniques to teach and would teach via simulation. Two procedures were selected as the most important procedures that the participants do teach via

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simulation but would like to teach in an improved way. We found 14 procedures that simulationists would teach if an adequate model was available, four of which are of high importance.

Conclusions: This study captured data to illuminate the procedural model gap and inform future interventions that may address it and meet the overarching objective to create better and more readily available procedure models for EM simulation educators in the future. It offers an informed way of prioritizing procedures for which additional homemade models should be created and disseminated as well as barriers to be aware of and to work to overcome. Our work has implications for learners, educators, administrators, and industry.

INTRODUCTION

Procedural education is an essential component of emergency medicine (EM) training and practice. Traditionally, curricula consist of a combination of didactics, simulated experiences, and supervised procedures within the clinical space.[1] Simulation-based education is an important means for procedural competency because it offers the opportunity to learn in a safe environment. Learners develop skills through supervised deliberate practice and the provision of feedback.[2,3] Due to a variety of factors, such as the introduction of new technology and changes in standards of care,[4,5] there has been a decrease in the overall number of procedures being performed, particularly some of the higher risk procedures, such as cricothyrotomy, pericardiocentesis, and lumbar puncture.[6] These high-acuity, low-opportunity procedures are increasingly taught via simulation given the lack of exposure in the clinical environment. With awareness of the increasing importance of simulated procedural education and training, there is an increased need to understand the ways in which residency programs are utilizing this resource and how they are teaching procedural skills.

Furthermore, the Society for Academic Emergency Medicine (SAEM) has determined by consensus that more research was needed to determine the best models and methods for procedural technical competence assessment.[7] The optimal setting and context of the procedure being conducted must also be considered.[8] An extensive review by Wang et al.[7] investigated the role of simulation in procedural skill acquisition. Consensus was reached that maximal skill retention would likely occur through procedure specific simulation-based training and evaluation.

Despite this call to action, a lack of evidence-based recommendations on simulation-based procedural training still remains. In particular, there are currently no standardized guidelines or metrics for task trainers to be used in procedural education during EM training. For some procedures, proprietary models exist that cost thousands of dollars, while some that may be used to teach the same procedure can be made for less than $100. There has been such demand that national courses have been developed to teach how to build and implement such low-cost models.[9]

The objective of this initiative was to identify and quantify the gap between EM procedures currently taught using simulation and those that educators would teach if they had better procedural task trainers. Additionally, we endeavored to identify which procedures were taught using homemade procedure models and barriers to use of additional homemade models. We anticipate that our study findings will be valuable to stakeholders of the EM simulation community of practice (as well as educators in specialties outside of EM) in decisions regarding investment of resources toward improvement of procedural training. This group encompasses a broad array of people reaching beyond the simulationist: EM learners and educators who need validated models for skills practice; scientists, engineers, and researchers who could optimize model functionality; administrators who seek to optimize patient safety and cost-effective learning; and industry who might promote and distribute improved models.

METHODS

Study design

The SAEM Simulation Academy Research Subcommittee on Procedure Education was formed in 2019 based on Academy consensus that focused attention would greatly benefit routinely discussed gaps in simulation procedure education. The Subcommittee met monthly by virtual video conference and reported directly to the Simulation Academy Executive Committee, most recently during the 2021 SAEM Annual Meeting. We identified a common problem of insufficient procedural task trainers for many EM procedures, despite anecdotes of many educators creating and utilizing homemade models. This led the Subcommittee to convene a group of expert simulation procedure educators to initiate this current study. An "expert" was defined as having completed a simulation fellowship training and at least 5 years of active simulation based procedural teaching for EM resident physicians. In addition, a recent simulation fellowship graduate was included to offer an end-user perspective.

After several rounds of consensus building, we generated several key questions to investigate. We ask participants to identify the key procedures that simulationists: 1) think should be taught via simulation, 2) do teach using simulation 3) would teach if they had a simulated/improved model, and 4) do teach with homemade models. In an effort to further explore reasons for these gaps, we asked about potential barriers and solutions to procedural teaching including use of homemade models. To better address these key questions, we endeavored to survey the academy membership. We preferred a survey over qualitative interviews because we wanted a broad base of experienced participants. We started the survey instrument design with a current literature review of simulation-based procedure education and models.

Survey design was initiated via a modified Delphi process. The CORD procedure list[10] served as an initial comprehensive list of EM procedures and contained 70 EM procedures. The group endeavored to systematically shorten this list to highest priority procedures in an effort to balance ease of survey completion with top procedure inclusion. Eight of the authors participated in both the first and the second rounds of the modified Delphi process.

For the first round, the expert simulation educator group selected 20 procedures they identified from the comprehensive list as least important for all of the three questions. Any procedure with high consensus (greater than 50% selected option) of low importance was eliminated. Two authors (S.B. and S.N.S.) collaborated to combine redundant or overlapping procedures (e.g., surgical airway and cricothyrotomy) and remove any procedures that do not require a task trainer (e.g. teams resuscitation training). This round concluded with a list of 38 unique procedures, which served as a basis for the second round of the modified Delphi process.

The second round focused on identifying the most important procedures per each of the main questions. Using the modified procedure list, the same expert group selected the top 20 procedures they identified as most important for each of the three main questions. Answers selected by more than 50% of the expert group per question were utilized for the final survey version sent out for this study. For the fourth question on the use of specific homemade models, the comprehensive list of 38 procedures was used. We incorporated demographic questions about roles and experiences in simulation, which permitted only procedural educators to complete the full survey. To streamline the survey and minimize survey fatigue, we deferred the typical demographic questions about sex, age, or geographic location. Our task force deemed these questions less important than those about their simulation demographics. The final survey version was modified through two rounds of refinement with input from the subcommittee and tested through a limited pilot distribution with minor changes added for clarity and readability. The study was deemed exempt by the institutional review board of the Icahn School of Medicine at Mount Sinai.

Study setting and population

Our target participants were EM simulation educators and researchers who actively taught residents. We chose to use the SAEM Simulation Academy as the survey target as it is the most active academic simulation group, and our work is part of a SAEM task force. We used a convenience sampling method during the months of September and October 2021. This time frame was chosen as it was after the busy summer orientation and vacation time but before the EM residency interview season. We distributed an anonymous, 12-question, web-based survey issued through email invitation (Qualtrics) to simulation academy attending physician and fellow members on the SAEM Simulation Academy listserv. Two additional follow-up reminder emails were sent.

Study protocol

The survey queried participants on general and simulation-specific demographic information, including simulation-based procedural education and novel model use. The first questions identified if respondents taught procedures; the survey ended for anyone who indicated they did not teach procedures. Subsequent demographic questions focused on simulation experience, current roles, and primary work site type. Core survey questions honed in on identifying the overlap and differences between the most important procedures overall, those which are taught, and those one would teach given better task trainers. The final set of questions focused on homemade task trainer use, barriers and solutions to their creation, and procedural teaching barriers and solutions. Completion of survey implied consent.

Key outcome measures

The key outcome measures of interest include the most important procedures to teach via simulation, those that are currently taught via simulation, and those that participants would teach de novo or in an expanded fashion if simulation models were available. Additional outcome measures include previously utilized homemade simulation models as well as perceived barriers to procedure education and to obtaining or making additional simulation models.

Data analysis

We compiled data only from completed surveys. We analyzed descriptive data with Excel (Microsoft Corp.). For multiple-choice questions, percentages were calculated as the number of selections for each answer choice per the number of completed survey respondents, because many questions allowed for multiple answers. We anticipated only a minority of SAEM Simulation Academy members responding as members may defer the survey to their department's main procedural educator. The size of EM simulation groups are variable and often range from one to six simulationists per group. We estimated an average of four simulationists per program, with one often being a dedicated proceduralist, for an estimated potential response rate of 25%. We calculated an adjusted response rate by using this estimate as a denominator. We classified responses to items by examining several factors: the relevance of the procedure to EM practice (must or would teach), the current state of the individual procedure (taught or not taught), and the type of model used (proprietary or homemade). Using this rubric, we identified three categories of model need: high need, need, or low need. We denoted models as "high need" if the procedure ranked greater than 50% on both "should teach" and "would teach." We categorized models as "low need" if the procedure ranked under 25% in "would teach." We identified the remaining models as "need."

TABLE 1 Modified delphi results per question

Procedure	Q1: Overall importance	Q2: Currently taught	Q3: Wish to teach	Q4: Novel models used
Airway management techniques	1	2		2
Analgesia -local and nerve blocks			3	1
Arterial catheter insertion		2		1
Arthrocentesis	1	2	3	3
Bladder Catheterization techniques				
Cardiac pacing	1	2		2
Cardiopulmonary resuscitation (CPR) skill	1	2		2
Cardioversion		2		1
Central venous access	1	2		2
Compartment pressure measurement				
Control of epistaxis			3	1
Cricothyrotomy/surgical airway	1	2		2
Defibrillation	1	2		2
Delivery of newborn	1	2		2
Drainage of hematoma				
Drainage of peritonsillar abscess	1		3	2
Escharotomy				
Fasciotomy			3	1
Foreign body removal from eyes or orifices	1		3	2
Fracture/Dislocation management techniques	1	2	3	3
Gastric tube techniques				
Incision and drainage of soft tissue abscess			3	1
Intraosseous line placement	1	2		2
Lateral canthotomy	1	2	3	3
Lumbar Puncture	1	2		2
Mechanical ventilation, ventilatory monitoring	1	2	3	3
Paracentesis	1	2		2
Pericardiocentesis	1		3	2
Perimortem c-section	1	2	3	3
Slit lamp examination	1			1
Testicular detorsion			3	1
Thoracentesis				
Thoracostomy	1	2	3	3
Tonometry				
Tooth stabilization			3	1
Trauma team resuscitation				
Trephination, nails				
Wound closure techniques	1	2		2

Note: Table illustrates the results of the modified Delphi process used to create the answer options for the four main research questions regarding key procedures and homemade task trainers. Highlights indicate greater than 50% rater agreement per question. Q1: Which are most important procedures overall TO TEACH via simulation? Q2: Which are the most important EM procedures that you or your sim team DO TEACH via sim? Q3: Which are the EM procedures that you would teach (or would teach in an expanded way) if you had a sim model (or improved model)? Q4: Have you created or utilized any home-made task trainers?

RESULTS

The most important 38 unique procedures extrapolated by our expert consensus panel from the 2019 Model of the Clinical Practice in Emergency Medicine[10] are listed in Table 1. Six procedures met criteria for inclusion in all three main questions: arthrocentesis, fracture/dislocation management techniques, lateral canthotomy, mechanical ventilation and ventilatory monitoring, perimortem Cesarean section, and thoracostomy.

We received a total of 37 completed surveys from a total of 238 potential listserv respondents for a response rate of 16%, which calculates to an adjusted response rate of 62%. Table 2 exhibits simulation-based demographic data, which is grouped by roles, experience, and medical center type. Half of the respondents describe their current role as EM simulation directors or faculty. Thirty-seven percent identified as residency core faculty, and the remining percentages represent a range of medical school, residency, or hospital leadership. The majority (79%) reported their primary worksite as an academic medical center and the remainder worked with residents at a community site. Sixty-eight percent of respondents reported working in simulation education for greater than 6 years, with the largest group of respondents (40%) reporting working in simulation education for 6–10 years. Twenty-eight percent of respondents had worked in simulation education for 0–5 years, with most having 3–5 years of experience.

Responses to the first question, "Which are the most important procedures to teach via simulation?" are listed in Figure 1. Over 90% of people selected cricothyrotomy/surgical airway and airway management techniques. Approximately 80% of respondents identified central venous access, cardiac pacing, pericardiocentesis, and thoracostomy. Responses varied widely after this stratum as delivery of newborn was the next procedure and was ranked at only 60%. Responses between 40% and 60% and listed in decreasing frequency include: perimortem c-section, lumbar puncture, lateral canthotomy, and cardiopulmonary resuscitation skills. The remaining procedures all ranked from 5% to 30%.

Responses to the second question, "Which are the most important emergency medicine procedures that you or your team do teach via simulation?" are listed in Figure 2. Central venous access and airway management techniques were the most common answers at 93%. Similar to Question 1, cricothyrotomy/surgical airway ranked above 90%. Cardiac pacing ranked at 79%. The next strata ran between 60% and 70% and included lumbar puncture, pericardiocentesis, and thoracostomy. Cardioversion, cardiopulmonary resuscitation skill, and defibrillation all ranked around 50%. Fracture/dislocation management techniques ranked the lowest at zero percent. The other eight procedures ranged from 14% to 46%.

Figure 3 exhibits responses from the third question, "Which are the EM procedures that you would teach (or would teach in an expanded way) if you had a sim model (or improved model)?" Responses were more varied with most falling between 44% and 65%. The most common selections ranked between 60% and 70% and included analgesia (local and nerve blocks), lateral canthotomy, and perimortem c-section. Fracture/dislocation management techniques followed at 56% and then drainage of peritonsillar abscess and pericardiocentesis, which tied at 53%. Eight procedures fell around 50%: control of epistaxis, foreign body removal from eyes or orifices, arthrocentesis, fasciotomy, and thoracostomy. The remaining procedures ranked below 30%.

Four procedures ranked highly on both Question 3 and Question 1 or 2. Lateral canthotomy, perimortem c-section, pericardiocentesis, and thoracostomy were selected as some of the most important techniques to teach via simulation in Question 1. Pericardiocentesis and thoracostomy were selected as the most important procedures that the participants do teach via simulation in Question 2.

TABLE 2 Simulation demographics

	Count (n = 38)	Percent
Do you teach procedures?		
Yes	37	97%
No	1	3%
What are your current roles? (select all)		
EM simulation faculty	19	51%
EM simulation director	18	49%
Core faculty	13	35%
EM residency assistant/associate program director	6	16%
Hospitalwide sim director	6	16%
Hospitalwide sim educator	6	16%
Other[a]	6	16%
EM residency program director	3	8%
Occasional EM simulation educator	2	5%
Current simulation fellow	0	0%
What type of medical center is your primary worksite?		
Academic	30	81%
Community hospital with residents	8	22%
Community hospital without residents	1	3%
Other	0	0%
How many years have you been in simulation education?		
6–10	14	38%
11–15	8	22%
3–5	6	16%
16+	4	11%
1–2	3	8%
<1 year	2	5%

Note: Thirty-eight people responded, but one did not teach residents and was excluded from the survey. A total n of 37 was used to calculate descriptive statistics.

[a]Includes medical school simulation director, POCUS sim director, EM research, and adjunct.

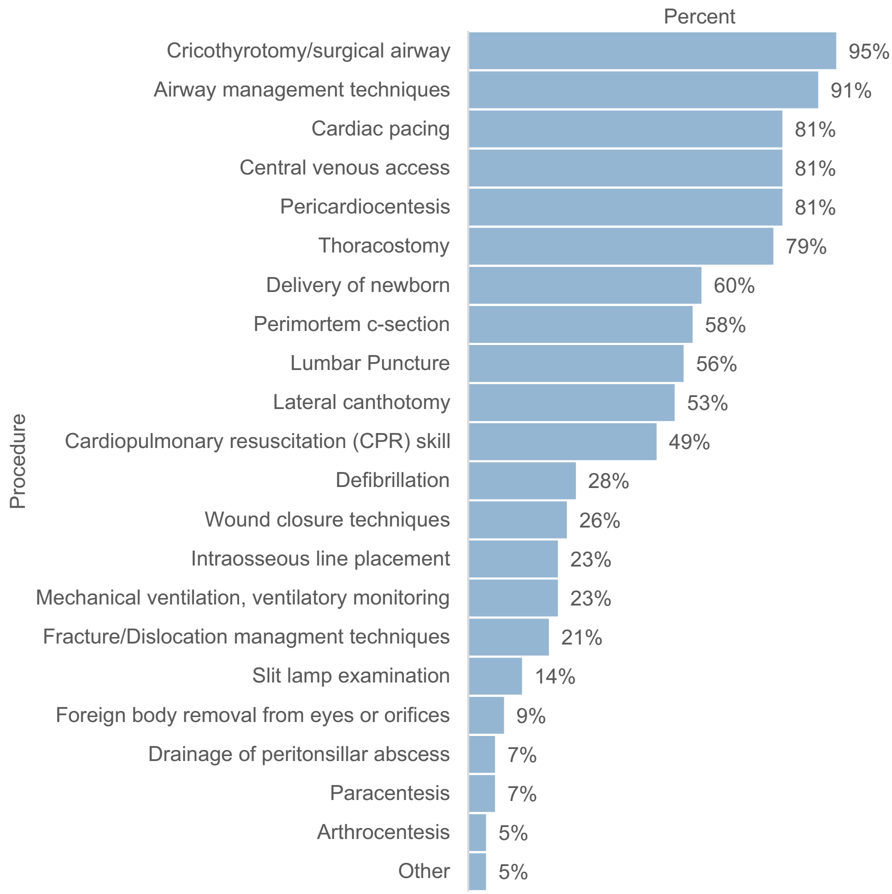
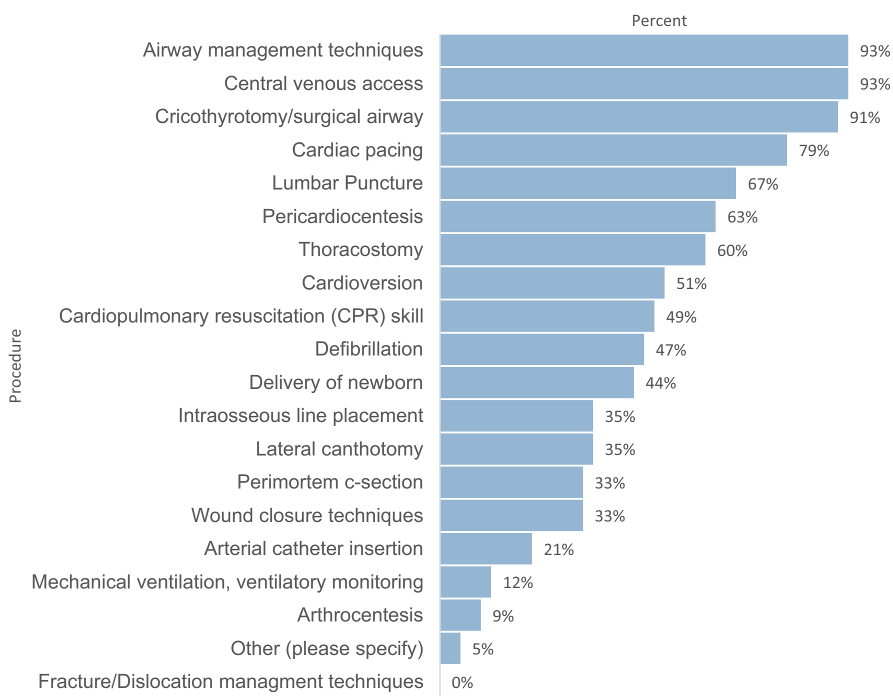


FIGURE 1 "Which are the most important procedures to teach via simulation?" The term "other" includes umbilical venous and arterial catheters, ultrasound guided peripheral IVs, resuscitation ethics

FIGURE 2 "Which are the most common procedures that you or your team do teach via simulation?" The term "other" includes umbilical venous and arterial catheters, ultrasound guided peripheral IVs, slit lamp use



All respondents (100%) reported making at least one type of model. Homemade models are categorized by system frequency in Table 3. Most people have made HEENT (head eyes ear nose throat) models with 54% making a lateral canthotomy model. Soft tissue was the second most common category with almost 50% making models for wound closure or abscess incision and drainage. The most

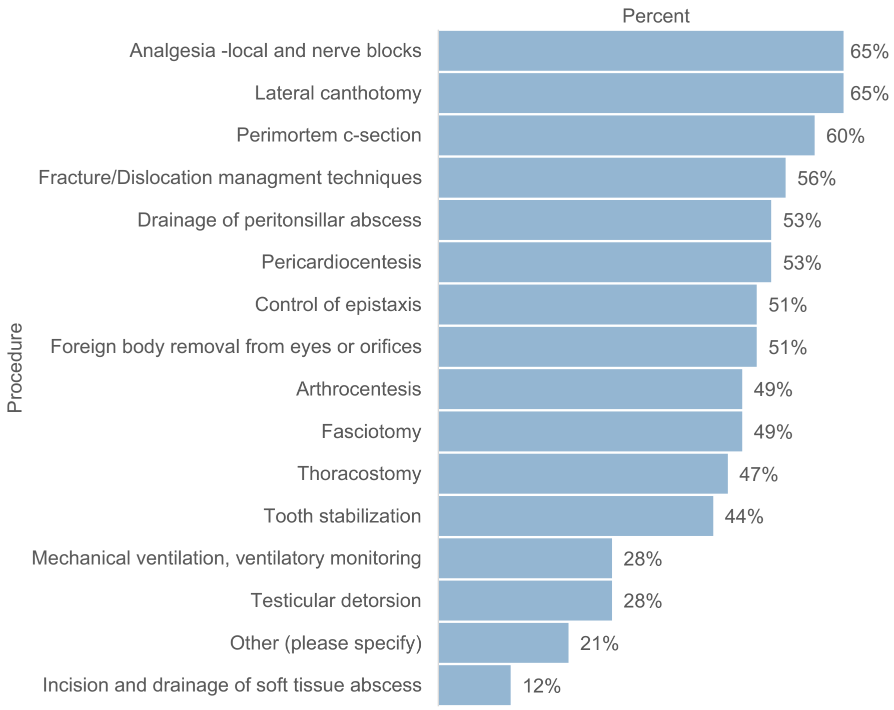


FIGURE 3 "Which are the most important procedures you and your team wish you could teach or teach better via simulation?" The term "other" includes thoracotomy (x3), transvenous pacing (x2), needle cricothyroidotomy/tracheostomy, complex laceration repair of face or other body parts with limited space/difficult angles; complex wound repair techniques like mattress sutures/corner stitches/figure 8 with bleeding vessels; midline catheters, resuscitation ethics

frequent cardiac model was pericardiocentesis (46%) followed by pacing (27%). Almost half the group have made their own cricothyrotomy task trainer. Approximately one-third of respondents have made a perimortem c-section and thoracostomy model. Orthopedic task trainers rank last at 5% for fracture/dislocation management. HEENT and orthopedic procedures were identified in Question 3 as needing better models for simulation procedural teaching.

Table 4 represents a comparative analysis between procedures ranked by those that were important to teach, were taught, would be taught, and novel models used to teach. Fourteen procedures were identified as needing a model or improved model to use for training: airway management techniques, arthrocentesis, control of epistaxis, drainage of peritonsillar abscess, fasciotomy, foreign body removal from eyes or orifices, fracture/dislocation management techniques, lateral canthotomy, mechanical ventilation/ventilatory monitoring, pericardiocentesis, perimortem c-section, testicular detorsion, thoracostomy, and tooth stabilization.

Of the barriers listed as impeding procedural teaching (Figure 4), most commonly mentioned were unavailability of procedural models (84%), limited ability to replace procedure model proprietary parts (58%), limited faculty/staff available to teach (49%), limited consumable kits/equipment (49%), and limited space to store procedure models (42%). When asked which factors have helped to advance procedural training, there were 29 unique narrative responses, with common themes including access to procedural trainer creators, funding for procedural trainer and testing, protected faculty procedural teaching time, and interprofessional collaboration opportunities. Participants identified many of these topics as barriers to obtaining or making additional models; most commonly mentioned were time (86%), money (77%), availability of recipe/guide (51%), and knowledge to make (44%).

DISCUSSION

Our study represents one of the first to ask EM educators engaged in simulated procedure education to identify procedural model gaps. In addition, our study examined the linkages between procedures deemed most important to teach, those actually taught, those educators would teach if a model were available, and the types of models used in teaching. The study results provide critical insight into contemporary trends, needs, and challenges associated with simulation for procedural task training in EM.

Strong positive correlations existed between almost all EM procedures identified as "most important to teach" with those that are "actually taught." Although we intuitively suspected that close alignment among the procedures within these two categories was highly likely, we were careful not to assume that such associations truly existed at the study's onset. We did, in fact, discover discordance between these two categories for four procedures: lateral canthotomy, pericardiocentesis, perimortem Cesarean section, and thoracostomy. All respondents in our study identified "need for better models" as the primary reason why these "most important to teach" procedures are not taught using simulation-based education. This finding confirms what many EM educators involved with simulation for task training have realized: for many procedures, especially procedures like lateral canthotomy, pericardiocentesis, perimortem Cesarean section, and thoracostomy, suitable commercially available partial task trainers do not exist, are cost-prohibitive, or lack characteristics that authentically approximate actual task haptics.

Not surprisingly, when facing imperatives to teach "must know" procedures in contexts where proprietary models are unavailable, respondents turned to homegrown innovation in attempts

TABLE 3 Homemade models by system

System	Procedure	Number ($n = 37$)	Percent
All			
	Any	37	100%
HEENT			
	Lateral canthotomy	20	54%
	Foreign body removal from eyes or orifices	8	22%
	Control of epistaxis	6	16%
	Drainage of peritonsillar abscess	5	14%
	Slit-lamp examination	4	11%
	Tooth stabilization	0	0%
Soft tissue			
	Wound closure techniques	17	46%
	Incision and drainage of soft tissue abscess	16	43%
	Analgesia–local and nerve blocks	6	16%
	Fasciotomy	4	11%
Cardiac			
	Pericardiocentesis	17	46%
	Cardiac pacing	10	27%
	Cardiopulmonary resuscitation (CPR) skill	2	5%
	Cardioversion	1	3%
	Defibrillation	1	3%
Airway			
	Cricothyrotomy/surgical airway	17	46%
	Airway management techniques	12	32%
Genitourinary			
	Perimortem c-section	14	38%
	Delivery of newborn	3	8%
	Testicular detorsion	0	0%
Respiratory			
	Thoracostomy	13	35%
	Mechanical ventilation, ventilatory monitoring	2	5%
Access			
	Intraosseous line placement	6	16%
	Central venous access	4	11%
	Arterial catheter insertion	1	3%
Gastrointestinal			
	Paracentesis	5	14%
Neuro			
	Lumbar puncture	3	8%
Ortho			
	Fracture/dislocation management	2	5%
	Arthrocentesis	1	3%

Abbreviation: HEENT, head eyes ear nose throat.

to create workable solutions to fill gaps. In fact, all respondents reported creating "homemade" models for at least one procedure listed (Table 3). For successful homegrown innovation, we inferred from the data that EM educators must be situated in contexts where infrastructure exceeds minimum threshold levels. EM educators, as individuals or collaboratively within teams, must also possess or have access to knowledge and technical expertise across domains like engineering, human factors/ergonomics, psychology,

TABLE 4 Gap analysis of models prioritized, available and needed

Procedure	Q1: Overall importance	Q2: Currently taught	Q3: Wish to teach	Q4: Novel models used	Model Need
Lateral canthotomy	53%	35%	65%	54%	High need
Pericardiocentesis	81%	63%	53%	46%	
Perimortem c-section	58%	33%	60%	38%	
Thoracostomy	79%	60%	47%	35%	
Analgesia–local and nerve blocks	N/A	N/A	65%	16%	Need
Arthrocentesis	5%	9%	49%	3%	
Control of epistaxis	N/A	N/A	51%	16%	
Drainage of peritonsillar abscess	7%	N/A	53%	14%	
Fasciotomy	N/A	N/A	49%	11%	
Foreign body removal from eyes or orifices	9%	N/A	51%	22%	
Fracture/dislocation management techniques	21%	0%	56%	5%	
Mechanical ventilation, ventilatory monitoring	23%	12%	28%	3%	
Testicular detorsion	N/A	N/A	28%	0%	
Tooth stabilization	N/A	N/A	44%	0%	
Incision and drainage of soft tissue abscess	N/A	N/A	12%	43%	Low need home made models used
Slit lamp examination	14%	N/A	N/A	11%	
Wound closure techniques	26%	33%	N/A	46%	
Arterial catheter insertion	N/A	21%	N/A	3%	Low need proprietary models used
Cardiopulmonary resuscitation (CPR) skill	49%	49%	N/A	5%	
Cardioversion	N/A	51%	N/A	3%	
Central venous access	81%	93%	N/A	11%	
Defibrillation	28%	47%	N/A	3%	
Delivery of newborn	60%	44%	N/A	8%	
Intraosseous line placement	23%	35%	N/A	16%	
Lumbar Puncture	56%	67%	N/A	8%	
Airway management techniques	91%	93%	N/A	32%	Low need home made and proprietary models used
Cardiac pacing	81%	79%	N/A	27%	
Cricothyrotomy/surgical airway	95%	91%	N/A	46%	
Paracentesis	7%	N/A	N/A	14%	

Color denotes models stratified by need assessment. Red for high need, orange for need, violet for low need home made models used, blue for low need proprietary models used, green for low need home made and proprietary models used.

and education) in addition to subject matter expertise. They require time, financial support, access to technology and office and laboratory space, and, perhaps most critical, an organizational culture with a willingness to foster collaborative cost-sharing practices and build strategic partnerships or other relationships within or beyond the traditional boundaries of the emergency medicine department, including those with other departments, university affiliates, corporations, professional societies, or public-sector entities. It is not surprising that our data indicate that the majority of home-grown innovative efforts happen among simulationists situated in environments with academic affiliations with residency programs, medical schools, and universities.

Our study provides important implications for all those invested in psychomotor skill development, maintenance, and skill decay prevention. The most direct beneficiary of this work is the simulationist, who may use this as a platform for novel model improvement, comparison, research, dissemination, or even collaboration between departments or industry. Administrators, malpractice carriers, and licensure bodies will appreciate the focus on safety and engagement. With improved functionality and validity, we anticipate that more

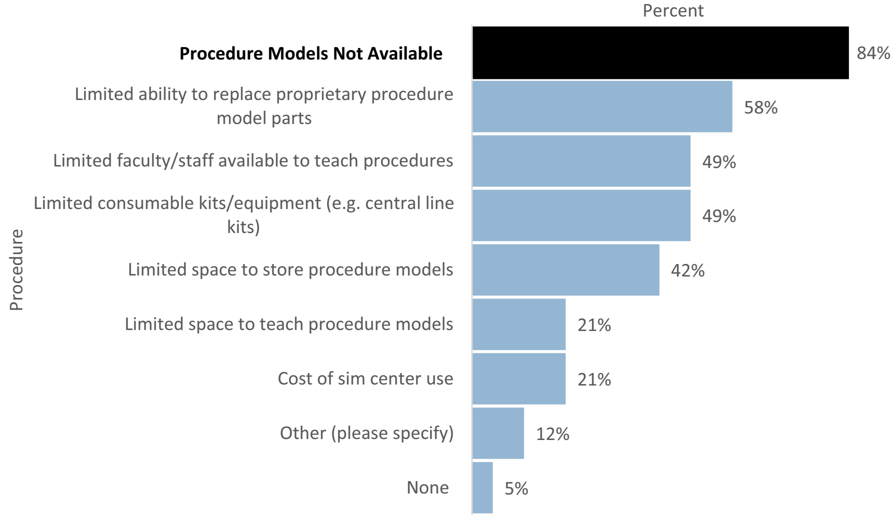


FIGURE 4 "Which barriers have impeded your procedural teaching?" The term "other" includes model cost, lack of time, resources or support to create models, lack of recipes or guides to create models, lack of standardized and validated teaching models

experienced learners will be more engaged and likely to practice,[11] thus avoiding potential skills decay. Safety- and teamwork-focused in situ procedural simulation may elucidate causes of potential errors before they occur,[12] showcasing work done versus work imagined.

Educators recognize the need for easy-to-use models that are validated and disseminated. Evidence-supported educational theory and best practices[2,13-15] (e.g., validity, mastery learning, deliberate practice) may amplify these models' benefits and advantageous features of models and overcome their limitations when designing and implementing curricula to facilitate learner skill development. EM learners benefit more when they possess clear, realistic perceptions of the trajectory psychomotor skill development takes.[15-18] Learners should feel comfortable and reassured that task trainers like these are used, when they possess characteristics, features, and adequate validity evidence to serve as effective tools for skill building and maintenance. Patients need physicians who learn and maintain procedural skills with maximal use of simulated settings. Nonclinician experts such as engineers, researchers, and corporations can provide crucial specialized knowledge and skills that may transform a basement project into a highly functioning, validated, and potentially profitable tool.

LIMITATIONS

Like other survey-based initiatives, there may be limitations to generalizability of the included sample. Because we focused on identifying procedural model gaps within U.S. EM residency programs, our results may only apply to U.S. EM training sites. These training sites were often predominantly in urban locations, and geographic data were not collected. This study likely does not accurately reflect rural or semirural procedural model gaps. Although we recognize that the low response rate is a limitation, this also reflects that many simulationists consider procedural education or model creation as a niche aspect of simulation. We feel that these responses provide a robust response related to the target goal of understanding the gap in which procedures should be taught versus which procedures are taught using available procedural task trainers. Additionally, a concise list of EM procedures was utilized for the final survey version to balance the feasibility of survey length to ensure respondents. The use of the modified Delphi panel was a deliberate and rigorous attempt to select the highest yield procedures.

Simulation-based procedure educators with 10 or fewer years accounted for approximately two-thirds of all respondents to our survey. Perspectives of educators within this demographic may have unduly influenced our results. For example, early-career simulation educators are often more affiliated with academic EM departments, where the predominant focus of procedure teaching may center on resident physician or medical student learners at novice and advanced beginner developmental levels (as described by Dreyfus and Dreyfus[18] and as measured by current models of competency-based medical education and entrustment). Simulation educators are most commonly responsible for the creation and implementation of simulation-based procedure training programs and curricula that facilitate initial attainment of procedural competency among these learner types. Educators often are required to focus on a specific set of procedures for early learners, and therefore their experiences using partial task trainers and other models may be greatest among those used for teaching these skill sets. The results of the survey might be different if more respondents responsible for procedure teaching for other purposes (e.g., prevention of skill decay, or new skill teaching to a more proficient expert learner group) responded. Educators teaching this more advanced learner group may need to teach different skills for which models are not currently available nor adequate. Educators reteaching previously learned procedures that integrate novel technologies to learners within developmental levels ranging from competent to expert may also require partial task trainers or other models with more technical sophistication and forms of fidelity.

CONCLUSIONS

In conclusion, this initiative utilized a survey of emergency medicine simulation educators to identify and quantify the gap between emergency medicine procedures currently taught using simulation versus those educators would teach if they had better procedural task trainers as well as to describe the most currently utilized homemade procedure models and barriers to use of additional homemade models. This study captures data to innovatively pave the way for informed future interventions to address this procedural model gap and meet the overarching objective to create better and more readily available procedural task trainers for simulation educators in the future. It offers an informed way of prioritizing procedures for which additional homemade models should be created and disseminated as well as barriers to be aware of and to work to overcome. Our work has important implications for learners, educators, administrators, and industry.

CONFLICT OF INTEREST

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AUTHOR CONTRIBUTIONS

Stephanie N. Stapleton contributed to study concept and design, acquisition of the data, analysis and interpretation of the data, drafting of the manuscript, and critical revision of the manuscript for important intellectual content. Michael Cassara contributed to study concept and design, interpretation of the data, drafting of the manuscript, and critical revision of the manuscript for important intellectual content. Tiffany Moadel contributed to study concept and design, interpretation of the data, drafting of the manuscript, and critical revision of the manuscript for important intellectual content. Brendan W. Munzer contributed to study concept and design, interpretation of the data, and drafting of the manuscript. Christopher Sampson contributed to study concept and design, interpretation of the data, drafting of the manuscript, and critical revision of the manuscript for important intellectual content. Eisha Chopra contributed to study concept and design and drafting of the manuscript. Jane Kim contributed to study concept and design and drafting of the manuscript. Ambrose H. Wong contributed to study concept and design, interpretation of the data, and critical revision of the manuscript for important intellectual content. Suzanne Bentley contributed to study concept and design, acquisition of the data, analysis and interpretation of the data, drafting of the manuscript, and critical revision of the manuscript for important intellectual content.

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