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REVIEW

SIMULATION-BASED TRAINING AND ITS USE AMONGST PRACTICING PARAMEDICS AND EMERGENCY MEDICAL TECHNICIANS: AN EVIDENCE-BASED SYSTEMATIC REVIEW

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ABSTRACT

Objectives: This systematic review (SR) describes how simulation-based training (SBT) is utilized by paramedics and emergency medical technicians (EMTs).
Review methods: Data sources: PubMed, CINAHL, Cochrane CENTRAL, Scopus, Web of Science, and Google Scholar were searched from 2010 to 2021. Standard SR methodology was utilized according to PRISMA guidelines. Eligibility criteria included English studies conducted in the United States, or Canada published between 2010 and 2021. Study designs were heterogeneous and had quantitative, qualitative, and mixed-methods projects. The specific populations included paramedics and EMTs.
Results: 595 articles were initially identified and reviewed, 25 of which met our inclusion criteria. The most common SBT areas of focus documented in the literature were general assessment and treatment (7 studies) and airway management (7 studies). Most of the studies were conducted in a mobile simulation lab (6 studies), simulation centers (5 studies), and ambulances (5 studies). Many studies report simulations involving manikins alone and a combination of manikins and simulated patients. Overall, 21 studies documented the use of high-fidelity simulation. Sixteen studies involved paramedics only, 8 involved both paramedics and EMTs, and one study involved only EMTs. Most of the impact of SBT appeared to be on objective measures such as performance, procedural success, and ability to identify errors, as well as subjective metrics such as perceived improvement in knowledge and skill. The degree of sustained impact of SBT on skill retention was not frequently reported, and direct enhancement in patient outcomes such as length-of-stay or mortality was not documented in any of the studies.
Conclusions: Paramedics and EMTs provide critically important, often lifesaving, prehospital care. However, the opportunities to enhance their skills are limited by several factors, most notably their undergraduate and certificate educational requirements, which are much shorter than many other allied health professions. Hence, paramedics and EMTs appear to rely on SBT more than many other clinical disciplines in allied health. Despite the widespread usage in these two professions, there are still knowledge gaps related to SBT usage patterns and the impact on their practice.

INTRODUCTION

Paramedics and emergency medical technicians (EMTs) are an essential part of Emergency Medical Services (EMS) and the overall health care field. These two health care professions are critical components of prehospital care provided to patients. They are trained to provide basic life support (BLS) and advanced life support (ALS), which involves complex knowledge and skills that enable them to provide patient care and transportation. Their primary responsibility is to provide care for critical and emergent patients in all types of situations. At times, their practice entails providing high-acuity but low-frequency interventions. Therefore, the acquisition and retention of these potentially lifesaving procedures may be limited. "Postevent analyses suggest recurring failures that even very senior emergency responders commit despite years of experience and high levels of traditional training."(1) To deliver effective care, a paramedic or EMT must be able to rapidly but correctly assess the patient and determine which critical interventions are appropriate, all while handling a stressful and, at times, hazardous environment.(2) Errors that are made in prehospital care have potentially significant medical consequences.

The current didactic training opportunities for practicing and enhancing skills are offered through lectures, journals, tabletop exercises, and web-based training programs. However, often, book knowledge does not translate into practical competency. This concept was delineated by Edgar Dale in 1969, who created a model called Dale's "Cone of Experience." Fundamentally, Dale explains that learners retain more knowledge and information by doing instead of simply hearing, reading, and observing. (3) Although methods of hearing, reading, and observing are valuable, they may not be valuable on their own. Engagement in simulation allows participants to get in a psychological mindset that is as realistic as possible, so it is as if they are treating an actual patient in a life-like scenario, depending on the level of fidelity chosen by those instructing. Simulation-based training (SBT) uses resources to teach new skills, communication, and leadership, while also providing a methodology to maintain skills.

According to Bredmose, Habig(2), simulation exercises are essential to test response plans on local and national levels. Thus, the effectiveness of first responders, such as paramedics and EMTs, can be evaluated. Task trainers, manikins, and role-playing are all modalities of simulation used in the prehospital environment by EMS personnel to train for large-scale emergencies. Simulations are entirely scenario-dependent and may focus on an individual skill or multiple skills to develop critical thinking abilities to drive competent assessments and treatment processes. Paramedics and EMTs can utilize these simulation modalities to improve the ability to provide physical exams, assess airway ventilatory status, manage airways, provide ventilation, access vasculature, administer medications, and ultimately assess and treat their patients effectively.

Some accrediting agencies endorse the need for emergency response simulation. "Local ordinances, state and federal regulations may address the frequency and level of simulations that are required to evaluate emergency response plans."(2) It is noteworthy that the Committee on Accreditation of Educational Programs for the Emergency Medical Services Professions (CoAEMSP) has recently amended its standards to find alternative pathways to education due to Coronavirus disease 19 (COVID-19). As of recently, the CoAEMSP permits "the use of alternative evaluation methods to include scenarios, case studies, and simulation as well as the adjustment of minimum competencies to satisfy the requirements of these standards for paramedic educational programs."(4) COVID-19 has necessitated educational programs to embrace new educational approaches such as simulation to determine competency in areas such as didactic and clinical experience. It is evident that in the pre-and post-COVID-19 worlds, SBT will be an important element in helping ensure the clinical competency of allied health professionals, including paramedics and EMTs. The amendment by the CoAEMSP reinforces the need for simulation in training professionals. This systematic review (SR) aimed to examine the literature on SBT in the allied health professions (AHPs) of paramedics and EMTs, including usage trends and their potential impact on these professions and the patients they serve.

MATERIALS AND METHODS

Protocol

The review was conducted and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement.(5) This study is registered with Research Registry, and the unique identifying number is researchregistry1296.(6)

Eligibility Criteria

The authors selected the studies based on the predefined inclusion criteria: 1) studies conducted in the United States or Canada, 2) in the English language, 3) heterogeneous studies, 4) quantitative, qualitative, and/or mixed-methods projects; 5) study populations focusing on paramedics and EMTs, and 6) publication time from 2010 to 2021.

Databases and Search Strategy

Databases searched for the project included PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Library, Scopus, and Web of Science, covering publication dates from 2010 – August 2021 when the literature searches were performed. Google Scholar was also searched to capture any gray literature such as doctoral dissertations not indexed on synthesized databases such as PubMed. Considering the search algorithm and ranking mechanism in Google Scholar are usually not transparent, and the search results are generally broad and large, the authors chose to select only the first 60 references, which tend to be more relevant. The search terms for the population concept are allied health personnel, emergency medical technicians, EMTs, and paramedics; the terms for the intervention category include simulation training, simulation-based training, SBT, interactive learning, and patient simulation; the terms for the outcomes are patient care, clinical competence, clinical skills, quality of health care, efficiency of care, hospital length of stay, patient safety, and patient satisfaction. Based on these major terms and examination of the test search results, the final search strategy used for PubMed is as follows:

> ("Allied Health Personnel"[Majr] OR "allied health personnel"[tiab] OR "Emergency Medical Technicians"[Mesh] OR "emergency medical technician"[tiab] OR "emergency medical technicians"[tiab] OR EMT [tiab] OR EMTs[tiab] OR

Paramedic [tiab] OR Paramedics [tiab]) AND (“Simulation Training”[Mesh] OR “Simulation training”[tiab] OR “Simulation-Based Training”[tiab] OR “SBT”[-tiab] OR “interactive learning”[tiab] OR “patient simulation”[tiab]) AND (“Patient Care”[Mesh] OR “patient care”[tiab] OR “Clinical Competence”[Mesh] OR “clinical competence”[tiab] OR “clinical skill”[tiab] OR “clinical skills”[tiab] OR “Quality of Health Care”[Mesh] OR “quality of health care”[tiab] OR “efficiency of care”[tiab] OR “Length of Stay”[Mesh] OR “hospital length of stay”[tiab] OR “Patient Safety”[Mesh] OR “patient safety”[tiab] OR “Patient Satisfaction”[Mesh] OR “Patient Satisfaction”[tiab])

Study Selection

In total, 595 records were retrieved from the five databases and Google Scholar. All the references were exported into EndNote 20 for citation management and removing 204 duplicate references (n=204). Manual deduplication was also applied to ensure there were no duplicate records. The remaining 391 references were screened at the title and abstract level by two reviewers. 42 studies were evaluated at the full-text level. As a result, 22 articles were selected after full-text evaluation. Three additional references were included from a later updated search. In total, there were 25 articles included in the final set of selected studies for data extraction and analysis. The flowchart (Figure 1) below indicates the process of study selection.

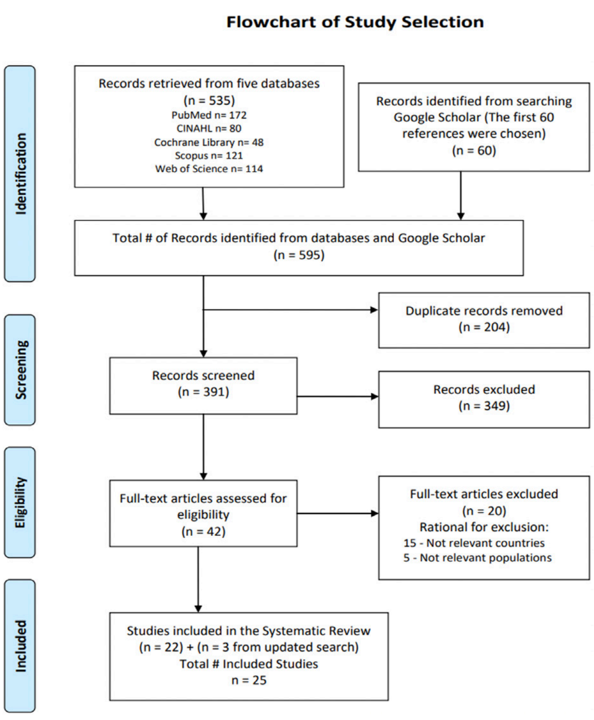

Figure 1 – Flow Diagram of the Searches, Screening, and Inclusion Process

Data Extraction Process

Specific data was searched for and extracted from each article using Microsoft Excel and Word tables. The following information was extracted from all selected articles and documented in Table 1: author(s), publication date, study purpose, study population, study design, study intervention, skill assessed, study setting, primary results, and Cochrane risk of bias (RoB). The SBT area of focus is the primary activity or management being investigated in the articles selected. The study setting is defined as the environment where the simulation activity took place. All the information was extracted by one author and verified by at least one other author. Discrepancies were resolved by a consensus between the two authors. For article assessment and data extraction, specific terms were created, utilized, and defined. These terms included: subjective outcome (e.g., participant perception), objective outcome (e.g., clinical outcome), equipment (e.g., manikin or standardized patient), level of fidelity (e.g., high or low), study setting (e.g., simulation center or mobile simulation lab), recording tool (e.g., audio/visual), pre and post orientation or assessment, and SBT area of focus (e.g., airway management or general management). Equipment, level of fidelity, study/practice setting, recording tool, pre/post orientation/assessment, and SBT area of focus were assessed and extracted from each article by all three authors. Discrepancies were resolved by consensus between all authors. Extraction of subjective and objective outcomes was determined by two authors, and discrepancies were resolved by consensus between all authors. The data that support the findings of this study are available from the corresponding author, JB, upon reasonable request. Per the PRISMA framework, a Risk of Bias (RoB) assessment for each study included was guided using the Cochrane RoB assessment tool. It is structured into several domains of bias, focusing on different parts of each study.

RESULTS

The initial database search yielded 391 articles after removing duplicates and before the title and abstract screening. We were left with 42 articles for a full-text screen according

Table 1 – Characteristics of included studies (n=25)

SBT=Simulation-based training, HF=High-fidelity, LF=Low fidelity, MSL=Mobile simulation laboratory, MSU=Mobile simulation unit, SC=Simulation center, SE=Simulated environment, PH=Prehospital, ED=Emergency department, PediSTEPPs= Pediatric Simulation Training for Emergency Prehospital Providers, Lung Ultrasound (LUS) FD=Fire department, ICU=Intensive care unit, Risk of bias=RoB, *=Study completed in Canada, **=Cochrane tool was used to guide judgment.

Author/Date	Study Purpose	Study Population	Study Design	Study Interventions	Skill Assessed	Study Setting	Primary Results	Risk of Bias (RoB) Cochrane Tool**
Alphonso et al. [7]	Develop and validate a checklist to evaluate clinical performance when caring for a physically abused infant in simulation	N=28 Paramedic, EMT	Qualitative study	Development of a performance checklist to evaluate provider screening behaviors and validate checklist	General Assess and Treat	SE	- Simulation helped create a checklist to identify child abuse with strong content validity and substantial interrater reliability; - Checklist is important for training, continuing education, and research	Unclear; Delphi method used, and consensus of content experts was employed
Asselin et al. [8]	Examine subject exertion and effort through 1) physical and biochemical measures 2) self-reports of perceived workload during out-of-hospital cardiac arrest resuscitation	N=40 Paramedic, EMT	Randomized nonblinded, controlled, experimental study	3 simulations: baseline simulation standard roles, repeat simulation standard roles, repeat simulation reverse roles	Resuscitation	SC	- Use of automating device appeared to reduce levels of physical exertion, and perceived workload in providers supplemented with just-in-time didactic, goal-directed algorithmic protocol, and resuscitation-assistive equipment	Unclear; Though the study was randomized and controlled, the study does not appear to have been blinded
Ayub et al. [9]	Identify attitudes, beliefs, and perceived barriers to providing patient and family-centered care (PFCC) and describe solutions to improve PFCC	N=122 Paramedic, EMT	Qualitative, Cross-sectional study	Study participants in the PediSTEPPS course	Other/Care Planning	PH	- Barriers to PFCC: limited manpower, multi-tasking medical care, and concern for interference with patient care; - Emotional support and effective communication are important to delivering PFCC	Unclear; Does not describe if participants were randomly selected
Bischof et al. [10]	Develop and validate a PH airway simulator and MSL that mimics care in an ambulance	N=18 Paramedic	Mixed-methods	Perform Endotracheal Tube Insertion (ETI)	Airway management	MSL	- MSL created a reproducible, HF learning environment; - MSL may allow trainers to test and identify knowledge deficits, derive future educational interventions, and standardize skill assessment	Unclear; Single site and participant selection process not described

Byars et al. [11]	Determine if paramedics can be trained to use an alternative airway device and evaluate their skill retention	N=40Paramedic	Prospective observational, single-group, descriptive cohort, educational trial	Paramedics were trained to use the Intubating Laryngeal Mask Airway (I-LMA) in simulation and had repeat testing one year out	Airway Management	PH	- Paramedics were able to deploy the I-LMA with high rate of success with a high rate of skill retention one year out	High RoB; Non-experimental, single site, and participant selection method unclear
Choi et al. [12]	Studied an experimental automation-assisted, goal-directed Out of Hospital Cardiac Arrest management protocol on resuscitation performance	N=40 Paramedic, EMT-B, EMT-I, EMT-C	Randomized control experiment, non-blinded	3 simulations: baseline simulation standard roles, repeat simulation standard roles, repeat simulation reverse roles	Resuscitation	Outpatient clinic	- Compared with traditionally trained EMS providers using standard equipment and protocols, EMS teams using the experimental algorithm and devices performed better pulmonary ventilation and medication administration	Unclear; Though the project is randomized and controlled, it was not blinded, and the participant selection method is unclear
Gable et al. [13]	Determine if a 3-hour educational course with simulation improves knowledge and confidence and examine experience with bariatric transport affected training outcomes	N=36 Paramedic	Mixed-methods	Participate in 1 of 2 simulations. Treat emergent traumatic and/or medical conditions, as well as extricate and transport bariatric patients	General Assess and Treat	FD	Simulation-based curriculum is an effective method of education; - Significant increase in knowledge and confidence with a 3-hour training session with simulation	Unclear; Study design was neither randomized, nor controlled, and was conducted at a single site
Hallihan et al. [14]	Evaluate safety and efficiency of an ambulance while providers delivered basic and advanced life support	N=106 Paramedic, EMT	Observational	Observe delivery of care to a simulated patient during an anaphylaxis scenario in a moving ambulance	Resuscitation	Ambulance*	Identified issues with patient compartment of the ambulance; - Safety was compromised by not wearing a seatbelt, standing with less than three points-of-contact, moving around cabling and tubing; - Efficiency of care was affected by lack of usable work surfaces, accessible storage and convenient sharps and garbage containers	Unclear; Study design was neither randomized, nor controlled and qualifications of expert evaluators unclear
Heiner and McArthur [15]	Examine ability to detect presence or absence of simulated fracture patterns with portable ultrasound	N=20 EMT	Observational	Simulation model with fractured turkey leg bone, evaluated with ultrasound	Imaging	PH	- Correctly detected the presence or absence of simulated long bone fractures with a high degree of sensitivity and specificity	Unclear; Study was neither randomized nor controlled, and convenience sample was used
Hoyle et al. [16]	Evaluate rate of medication errors before/after implementing a pediatric dosing reference (PDR)	N =65 Paramedic, EMT	Observational	4 simulations: seizing, cardiac arrest, burn, anaphylactic shock	General Assess and Treat	MSU + SC	- After introducing PDR and training, medication errors decreased; - Incremental improvement in patient safety	Unclear; Study was neither randomized nor controlled
Joyce et al. [17]	Determine if simulation training was a feasible and reliable method to learn how to verify placement of endotracheal tube (ETT) using ultrasound	N=20 Critical Care Paramedic	Observational	Paramedics with no ultrasound experience volunteered for a 3-hour training session and 5 simulated case scenarios	Airway management	PH	- Ultrasound use can be effectively taught using SBT; - All paramedics “agreed” or “strongly agreed” SBT was useful; - Simulation provided realistic view of pathology during ETT placement	Unclear; Study was neither randomized nor controlled

Lammers et al. [18]	Identify the most common causes of errors during simulated, pre-hospital pediatric emergency	N=90 Paramedic, EMT	Mixed-methods	Simulation of an infant with altered mental status, seizures, and respiratory arrest	Resuscitation	MSU	- Simulation valuable to discover errors and unrecognized error-producing conditions - Simulation, followed by debriefing, uncovered causes of active cognitive, procedural, affective, and teamwork errors, latent errors, and error-producing conditions	Unclear; Study was neither randomized nor controlled
Lammers et al. [19]	Identify causes of prehospital medication errors observed during simulated pediatric anaphylaxis	N=142 Paramedic, EMT	Mixed-methods	20-minute simulation of a 5-year-old in respiratory distress and hypotension from anaphylaxis	Other/drug administration	MSU	- Simulation, followed by debriefing, identified multiple causes of medication errors	Unclear; Study was neither randomized nor controlled
Lammers et al. [20]	To compare the effectiveness of four training methods in management of pediatric emergencies for paramedics	N=147 Paramedic	Observational and Randomized	Three simulated pediatric emergencies using 1) HF, 2) LF, and 3) Lecture	Resuscitation	Classroom	- SBT of paramedics in the management of pediatric emergencies over the course of 2.5 years was associated with a significant improvement in some of the skills included in the training, as measured by performance-based assessment.; - A lecture/lab approach also produced an improvement; - No improvement was found in the group who used an online course.; - LF simulation training was more effective than HF simulation for this group of learners	Medium RoB, Study was randomized, convenience sampling was used
Leblanc et al. [21]	Examine acute stress responses and performance during simulated high-stress scenarios	N=22 Advanced Care Paramedic	Cross-over study	Participated in one 3-hour session that involved participating in both low stress and high stress scenarios	General Assess and Treat	Ambulance*	- Greater increases in anxiety/cortisol levels in high-stress compared to low-stress scenario; - Clinical performance and documentation are impacted due to acute stress; - Highlights importance to develop systems and training interventions	Low RoB because validated, objective measures of stress hormones used, and blinding employed
Maloney et al. [22]	To determine if various ambulance driving conditions (stationary, constant acceleration, serpentine, and start-stop) would impact paramedics' abilities to perform Lung Ultrasound (LUS)	N=17 Paramedic	Prospective interventional study	Received a 45-minute LUS lecture. They then performed 25 LUS exams on both SPs and using simulation software, in each case looking for lung sliding, A and B lines, and seashore or barcode signs	Imaging	Ambulance	- Paramedics can correctly acquire and interpret simulated LUS images during different ambulance driving conditions; - Simulation techniques better adapted to this unique work environment are needed	Medium RoB; block-randomized used along with small sample size
March et al. [23]	Determine whether ground-based paramedics can be taught and could retain skills necessary to perform wire-guided cricothyrotomy (WGC)	N=55 Paramedic	Retrospective study	Teach WGC update program with open-ended practice. Minimum of 5 successful simulations and retention assessed	Airway management	SE	During initial training 100% of paramedics were successful in performing all 16 steps of WGC; - 87.3% retained skills to perform WGC; - Paramedics can be taught and retain skills to perform simulated WGC	Unclear; Measures used in the retrospective study to minimize bias are not stated

Mausz et al. [24]	Explore clinical performance in settings where "deliberate practice" and "feedback" are inconsistent or limited	N=30 Paramedic	Mixed methods	Two recorded simulation sessions involving airway management - Airway management	SC*	- Highly variable practice patterns, idiosyncratic decision paths, and schemas governed practice; - Deficiencies exist with situational awareness, decision making, and procedural skills; - Supports ongoing clinical competence	Unclear; Study was neither randomized, nor controlled and participant selection method is unclear	
Panchal et al. [25]	Assess comprehensive airway management practices during difficult airway simulation	N=198 Paramedic	Observational	Observation of airway management skills in active paramedics	Airway management	MSL	- 9% were prepared with backup plan and 63% successfully placed backup airway in 3 tries; - Comprehensive airway management challenged experienced paramedics; - There is a need to improve training and practice with simulations	Unclear; Study was neither randomized, controlled, nor blinded and convenience sample was used
Shah et al. [26]	Determine if PediSTEPPs enhances seizure protocol adherence for seizing children	N=250 Paramedic	Retrospective controlled study	Study transport of 0–18-year-old seizing patients. Management compared between EMS crews with at least one paramedic who attended PediSTEPPs and crews that had none	General Assess and Treat	FD	- Differences may exist in protocol adherence between paramedics with SBT and those without; - Odds of administering drugs was higher when PediSTEPPS trained ; - No differences in complications, ICU admission rate, or length of stay between patients exposed to trained and non-trained providers	Low RoB despite the retrospective nature, the study appears to have been controlled and objective measures of protocol adherence used
Smith et al. [27]	Study the cognitive strategies used by expert paramedics to understand how paramedics and the EMS system can adapt to new challenges	N=10 Paramedic	Observational	Conducted a "staged-world" cognitive task analysis to explore handling of 2 challenging simulation scenarios	General Assess and Treat	Conference	- Expert paramedics made more assessments, anchored less strongly to their initial impressions, and acted more strategically than those less experienced ; - Supports development of better exercises which facilitate the development and assessment of expertise	Unclear; Study was neither randomized, controlled, nor blinded
Stevens et al. [28]	Evaluate prefilled medication syringes	N=10 Paramedic	Prospective, block-randomized, crossover study	2 simulated pediatric arrests using either prefilled, color-coded-syringes (intervention) or conventional ampoules (control)	Resuscitation	Ambulance	A novel color-coded, prefilled syringe decreased time to medication administration and significantly reduced critical dosing errors; - Implementing standardized systems may facilitate appropriate patient care and contribute to improved outcomes	Unclear; Despite the study being randomized and blinded, a convenience and small sample was employed

Studnek et al. [29]	Assess association between performance of practicing paramedics on an exam and field performance assessed via simulation	N=107 Paramedic	Observational study	Participants randomly assigned to one of six simulations and after completed a national exam	General Assess and Treat	SC	- Results suggest that success on a valid and reliable certification exam correlates with a passing score on a single simulated patient encounter	Unclear; Convenience sample used
Tremblay et al. [30]	Investigate the influence of human factors associated with time pressure, patient-care intervention, and health status on the physiological responses of simulated emergency driving tasks	N=17 Paramedic	Quasi-experimental design	Performed 3 simulated driving tasks: 1) 1 non-urgent and 2) 2 urgent driving simulations (1 to the scene and 1 to the hospital). The 2nd urgent driving task was preceded by a patient-care simulation (unstable cardiac patient with cardiopulmonary resuscitation)	Other/ Transport	Ambulance simulator*	- Experienced paramedics manage the influence of time pressure and the impact of challenging patient-care well; - Paramedics with health conditions represent an elevated risk of collision	Unclear; convenience sample used, and a small sample size was employed
Way et al. [31]	Develop and derive an instrument to assess airway management proficiency	N=197 Paramedic	Observational study	Simulation of airway management was recorded and used to develop a performance assessment instrument	Airway management	MSL	- Created an airway management proficiency checklist, a performance assessment instrument which identified important tasks required for airway management; - Instrument contributes to improving training and measuring performance	Unclear; Study was neither randomized, controlled, nor blinded

to the eligibility criteria. A comprehensive review of all articles was completed by two reviewers, which left 25 articles that met the inclusion criteria and which are included in Table 1. The reasons for exclusion are reported in Figure 1. 21 studies were completed in the United States, and four were completed in Canada. Overall, there was a wide range of themes populated from the selected articles. Many studies were described as observational, mixed methods, and designs other than randomized, controlled trials (RCTs).

Of the 25 articles selected, 16 of them focused on the paramedic population, 8 of the articles focused on both paramedics and EMTs, and 1 article only focused on EMTs, represented in Figure 2. In total, paramedics were involved in SBT in 24 of the articles and EMTs were involved 9 articles.

General assessment and treatment and airway management (i.e., field performance, adherence to protocol, adherence to checklists) were the most common SBT areas of focus by paramedics and EMTs, representing seven articles each as seen in Figure 3. Resuscitation management was the next most common area of focus of the manuscripts selected, representing six articles. The remaining areas of focus of SBT included two categories 1) other (i.e., care planning, drug administration, and transport), and 2) imaging. Direct enhancement in patient outcomes such as length-of-stay or mortality was not documented in any studies.

Table 2 addresses common themes within each selected article. The most used modalities of simulation included manikins ten times (40%) and a combination of manikins

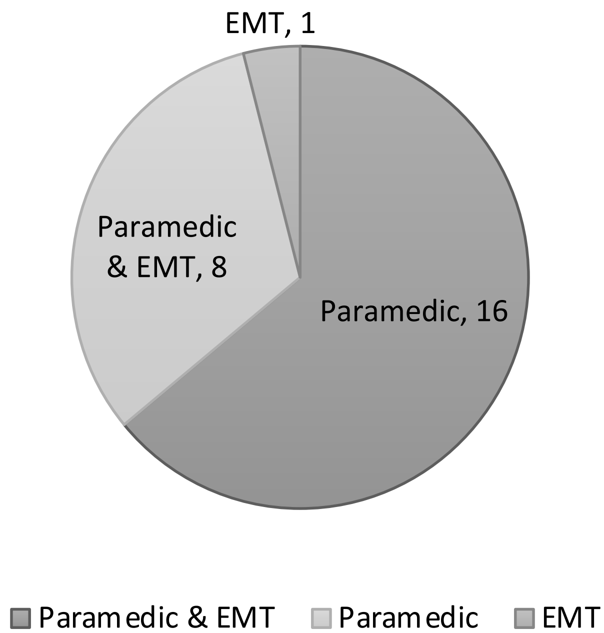

Figure 2 – # of Articles by Profession (n = 25)

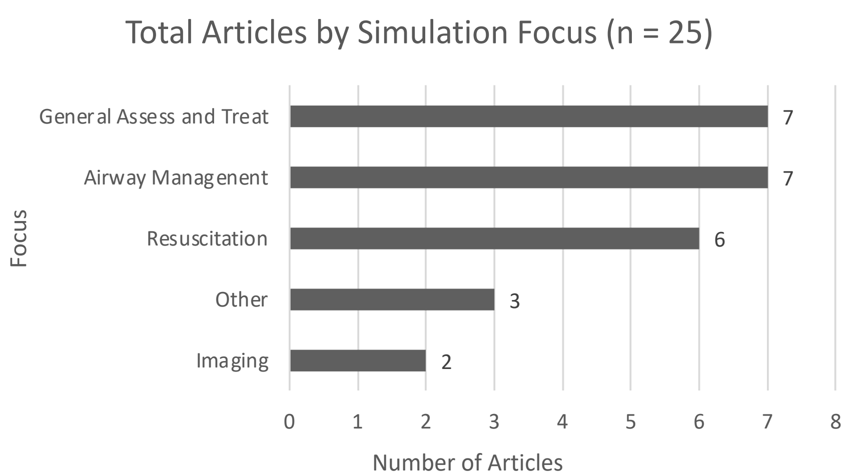

Figure 3 – SBT Area of Focus (n=25)

and simulated patient/actor eight times (32%), four times (16%) reported using other types of modalities (e.g., bone, images), and three times (12%) reported using simulated patient and actor. The majority of articles discussed the use of simulation modalities, which fall under high-fidelity simulation (HFS), 20 times (80%), compared to low-fidelity simulation (LFS), which appeared three times (12%), and mixed fidelity two times (8%). Nash, Joshi(32) describe HFS as a resource that utilizes higher degrees of realistic experiences and often utilizes technologies to imitate events or environments in which a real scenario may be experienced. In HFS, participants partake in scenarios with different medical equipment, which may exist in simulated settings or in-situ (real) settings, while simultaneously, the equipment may be connected to a simulated patient and/or computer interface. HF simulators are designed to have the ability to talk, breathe, blink and respond automatically or manually.(33) Low-fidelity simulation (LFS) requires less realism and fewer resources than HFS. Instead, during LFS, participants learn how to use and operate equipment in less stressful situations. As opposed to HF simulators, LF simulators are often stationary and even lack realism and situational context. The most common setting for

Feature	Articles	Percentages
Modality		
Manikin	10	40%
Both Manikin & Simulated Patient	8	32%
Other	4	16%
Simulated/Standardized Patient & Actor	3	12%
Fidelity		
High Fidelity	20	80%
Low Fidelity	3	12%
Mixed-Fidelity	2	8%
Study Setting		
Mobile Simulation Lab/Unit	6	24%
Simulation Center/Lab	5	20%
Ambulance	5	20%
Prehospital	4	16%
Other	3	12%
Fire Department	2	8%
Type of Media		
Audio + Video	15	60%
Unknown/Not Mentioned	7	28%
Video	3	12%
Audio	0	0%
Pre and Post Simulation Session		
Both Pre + Post	16	64%
Pre	6	24%
None	2	8%
Post	1	4%

Table 2 –Common Features of Articles (n=25)

performing SBT was mobile simulation labs and units, seen six times (24%) within the articles selected. Simulation centers/labs and ambulances were described five times each (20%). The prehospital setting represented four articles (16%). Locations mentioned once and categorized within the other category included an outpatient clinic, conference room, and a classroom, representing three articles (12%). The use of a fire department as a study setting was described two times (8%). 15 articles (60%) describe using both audio and video recording, seven articles (28%) do not mention using any type of media, three articles (12%) described the use of only video media, and zero (0%) mentioned the use of only audio media in conjunction with SBT. 16 articles (64%) describe the use of some form of pre-and post-training, assessment, pre-brief/debrief, or orientation before engaging in SBT activity, six articles (24%) mentioned the use of pre-training, assessment, or orientation. In comparison, two articles (8%) did not mention the use of any pre or post interventions, one article (4%) mentioned utilizing post debriefings or assessments. In total, 22 articles included a form of pre-simulation orientation training, educational session, briefing session, questionnaire, or pre-test, and 17 articles included a post-simulation assessment, exam, or debriefing and post-assessment processes.

DISCUSSION

Within the realm of SBT in allied health, Heuer, Bienstock(34) demonstrated that paramedics and EMTs are among the heaviest users. This article did speculate that such relatively heavy reliance on SBT may be related to the confluence of high acuity and out-of-hospital practice setting, coupled with shorter academic curricula than other AHPs. However, Heuer, Bienstock(34) and the literature selected as a whole did not delve deeply into the specific clinical competencies emphasized by these two specific professions, the types of simulations, nor their potential impact on perceived or objectively measured competency, as explored in this project.

Not surprisingly, the most heavily emphasized competencies in these two professions were related to airway management, along with general assessment and treatment. The general assessment and treatment category is an ensemble of skills, which in some cases were diagnostic and therapeutic. General assessment and treatment (7 articles) and airway management (7 articles) account for a total of 14 of the 25 selected articles (56%) (Figure 3). In most states, paramedics and, in some cases, EMTs can perform endotracheal intubation and other forms of airway management. In an out-of-hospital setting, airway management is invariably emergent or urgent, often an essential aspect of cardiopulmonary resuscitation or trauma management that occurs in the field. Likewise, assessing and treating patients is foundational to the role of the paramedic and EMTs, possibly explaining the frequency of SBT in this area since this is the heart of the profession. With paramedics and EMTs performing such critically important procedures, SBT appears to be used in their training because it permits hands-on skill enhancement in a safe environment, which is also conducive to repetition and skill retention.

Because paramedics' education and training require additional course work, time, and certification, it makes sense that 16 of the 25 selected articles focused on the paramedic population only, whereas 8 of the articles focused on both paramedics and EMTs and 1 article only focused on EMTs (Figure 2). Thus, paramedics were involved in 24 of the 25 selected articles. Comparatively, EMTs were involved in 9 out of the 25 selected articles. This finding was contrary to the overwhelming higher prevalence of practicing EMTs, who outnumbered paramedics by 322,517 to 120,397.35 Though the reasons for this paradoxical result were not entirely clear, it may be related to a combination of a broader and more complex scope-of-practice, as well as a higher scholarly reporting of SBT usage by paramedics.

An examination of the features of the SBT for these two professions also demonstrated some interesting patterns. The use of high-fidelity simulation and specifically manikins and simulated patients, predominated. This finding was probably a function of the need to replicate realistic experiences to gain proficiency in the high-acuity procedures performed by these clinicians in resource-limited settings. It also may explain why most simulations employed both audio and visual features, which in some cases enhanced the fidelity. Simply put, paramedics and EMTs have limited educational requirements relative to other AHPs but often practice in high-acuity environments. Hence, high-fidelity simulations that often include audio-visual components may augment formal training and better enable these professions to perform life-sustaining procedures right the first time.

A similar rationale may explain their use of pre-post assessment of the SBT in these professions. The high-stakes environment in which paramedics and EMTs function may encourage the need to determine if the SBT made a difference. This is supported by the notion that almost two-thirds of the manuscripts incorporated some form of assessment. Most of the articles selected (22 studies) included pre-simulation orientation training, educational session, briefing session, questionnaire, or pre-test. Similarly, many articles (17 studies) included a post-simulation assessment, exam, or debriefing. Only two articles did not include a pre and/or post-simulation briefing/debriefing educational process, demonstrating the importance of utilizing simulation in conjunction with formal pre-educational and post-assessment processes.

A surprising finding was the dearth of literature on virtual reality (VR) as a form of SBT in these two AHPs. Though the reasons for the lack of literature related to VR simulations were not entirely clear, it may be due to the relative newness of this form of simulation and the related point that the research and scholarship have not yet been completed and published. According to Saxena, Kyaw(36), "the advantage of learning in a VRE is that it provides new experiences that are not too costly to administer, and at the same time provides new experiences in circumstances that might not be feasible to implement in a real-world setting." Even though our SR did not uncover VR use, studies in VR for paramedics and EMTs represent an opportunity for future work in this area.

Another area worthy of further research is the impact of SBT on sustained clinical outcomes post engagement in SBT activities. Several studies included an evaluation of skill retention several months later. However, the assessment of skill retention was not commonly cited. Given the importance of long-term skill retention, this is also an area of focus that can be capitalized on in future studies involving practicing paramedics and EMTs and their use of SBT. Furthermore, most of the impact of SBT appeared to be predominantly on objective measures such as performance, procedural success, and ability to identify errors. Although some studies addressed subjective metrics such as perceived improved knowledge, skill, and confidence, this was done to a much lesser degree. Likewise, directly enhanced patient outcomes on aspects such as length-of-stay or mortality were not documented in any of the studies.

Like many projects of this sort, there were inherent limitations in this SR. These included excluding students from the sample population, which isolated information regarding the overall use of simulation amongst paramedics and EMTs' education and training. Utilizing this information might provide additional information surrounding more common and even unique and innovative applications of SBT within the profession. Instead, the decision to not include SBT, which involves students, presents an area of focus for a future SR. Another recognized limitation of this SR was that it was completed during COVID-19. As we were writing this SR, we speculate that many paramedics and EMTs were forced to utilize SBT to bridge training gaps while incorporating novel SBT methodologies and techniques during the COVID-19 pandemic. The amendment by the CoAEMSP due to COVID-19 reinforces the need for simulation, not only in educating students, but also in training practicing paramedics and EMTs. Future studies should evaluate the impact of COVID-19 on the use of SBT by paramedics and EMTs. Nevertheless, even with these considerations in mind, this project added to a growing body of knowledge related to SBT in the related fields of practicing paramedics and EMTs, some of which may apply to other health professions as well.

CONCLUSION

Paramedics and EMTs provide critically important, sometimes lifesaving, prehospital care. However, their opportunities to hone their skills are limited by undergraduate and certificate educational requirements, which are much shorter than many other AHPs. Hence, paramedics and EMTs appear to rely on SBT more than many other clinical disciplines in allied health. Despite the widespread usage in these two professions, there are still knowledge gaps related to SBT usage patterns and their impact on practice. While this project has provided some insights and contributes to a growing body of literature in this area, there is more work to be done to ensure that paramedics and EMTs, and more importantly, the patients they serve, receive the most benefit from this form of training.

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