

## Education

# The current state on the use of simulation in paramedic education

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<https://doi.org/10.33151/ajp.18.903>

## **Abstract**

This article presents the current state of the literature regarding the use of simulation in the field of paramedicine. It provides the reader with an overview on the current knowledge with the view to inform and foster innovation and development around simulation in paramedic education. We hope that other researchers will use this work to further inform and develop their simulations, not only for the purposes of assessment but also for learning and teaching in paramedicine.

### Keywords:

simulation; paramedicine; learning; teaching; education

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## Introduction

The term 'simulation' has been previously defined as 'techniques that imitate pre-hospital patient situations and are designed to demonstrate procedures, decision-making, and critical thinking' (1). The purpose of this article is to provide the reader with a systematic map as it relates to simulation in the field of paramedicine.

A systematic map is a type of literature review that maps out and categorises the existing literature on a particular topic which serves to identify gaps in the research literature from which other reviews and/or primary research could be derived (2). Our review is not concerned with students' perceptions of simulation but rather aspects of the simulation itself. We hope that by setting this scene we can establish a starting point from which further developments in the simulation environment can be made.

## Methods

The databases Medline, ERIC and Cinahl yielded a total of 264 references from the period 1988 to 2020. The search terms used for each database were: Simulation AND Emergency Medical Technicians AND Education; simulation AND (paramedic or EMS or emergency medical service or prehospital or pre-hospital or ambulance or emergency medical technician or EMT) AND (education or school or learning or teaching or classroom or education system) and simulation AND paramedi\* AND education, respectively.

## Results

A total of 25 relevant papers were found and are presented below in four themes: the simulation literature is specific and creative; simulation for assessment; simulation for teaching and learning; and empirical research on the efficacy of simulation learning is sparse.

### **The simulation literature is specific and creative**

The earliest published demand that advocated for the use of simulation in education was highlighted by the decisions made by two tertiary institutions. These institutions decided that they were no longer going to use dog labs to train their medical professionals, instead choosing to use simulation (3,4). Since then, authors that have published literature in this field have varied considerably in their aim and scope.

One of our initial findings was that multiple journal articles are focussed on describing just one specific aspect of simulation. Four studies focussed on describing just the physical set-up of their simulations. One paper described the use of an indoor and outdoor simulation centre designed to provide a more realistic experience for training in undergraduate paramedic education (5). Another described that the University of Hertfordshire had opened an accident simulation centre that offered pre- and post-registration paramedics the opportunity to experience a range

of scenarios in a real-life but secure environment (6). Another paper described that the University of the Sunshine Coast had set up a nursing training area to replicate a nursing home. In this nursing home simulation, elderly participants playing roles with varying ailments were treated by nursing students. The authors of this paper stated the goal of this simulation was to support 'real life' nursing in aged care work (7). The final study related solely to the description of the physical set-up of simulations involving a fire department and education centre for training fire fighters, emergency medical technicians (EMTs), first responders and paramedic. It described the physical aspects of a 330-acre property that included a working fire station and a six-story tower used for simulated fires, a house, a hotel and an education building (8).

Two papers focussed on how educators should run simulations. One paper advocated for active learning in general, and highlighted the importance of doing scenarios in real-time (8). The other was a theoretical piece that stated very broadly the learning principles related to simulation and gaming; stressed the importance of balancing virtual methods with face-to-face interaction; and examined the design principles that place learning before technology in an emergency response organisational context (9). The six studies indicate that, in the current literature, there is no comprehensive method or best-practice guidelines that educators can use to set-up and run effective simulations for learning in paramedicine. It seems that physical requirements and simulation design are specific, and no clear guidelines are available for educators wanting to learn how to run simulations in paramedicine.

Although the research regarding simulation in paramedic education is currently limited in scope, it did appear to foster some level of creativity in the field. One study described the testing of a difficult airway simulator. Paramedics were tested using this new simulator with the results showing a marked decrease in the rate of successful intubations (10). In another study, paramedics were engaged to provide information on two different types of defibrillators. Paramedics were observed using these two types of defibrillators on a SimMan and by doing so, provided the researchers with invaluable information about the usability of each device (11). In a different study, paramedics were recruited to provide extensive feedback on several different features associated with a SimMan. This information aided in shedding light on whether this particular SimMan was fit for purpose (12). The creative side of simulations is highlighted by one study that described the type of simulator they wished they had. In this paper, the researchers proposed a new 12-lead electrocardiogram (ECG) training model mannequin that has no markers on its chest, that provides ECG data and that also responds to medication (13).

The four studies described above clearly highlight that the simulation environment can be a place where new designs are evaluated, user data is collected and where new ideas for new and better simulators can be developed.

### **Simulation for assessment**

Simulation is often used for the sole purpose of assessment. Our analysis of the literature found multiple studies that describe educational programs where students or emergency responders have undertaken a course that is focussed on a specialised topic or skill. After undertaking that course, the students are assessed on their competence or skill using a small number of simulation scenarios. One study used one scenario to assess their students whereas two other studies used four (1, 14-16). This demonstrates that the term 'simulation' is often used in reference to scenario-based testing.

Certain factors have been found to influence performance on simulation-based assessments. One study found that paramedic clinical test scores could be influenced by whether the paramedic had undertaken 'work-based assessment' or whether they had undertaken 'simulation-based assessment' (17). One study focussed on the effect of stress on paramedic performance (18) and another on blood pressure measurements on a simulated arm in a noisy versus a quiet environment (19). Again, paramedic performance was determined using a single exposure to a clinical scenario or simulation.

Simulations have been used to assess team performance in competitions. One cross-sectional study described how paramedics and physician teams participated in the 19th International Emergency Medical Service competition in Europe. Paramedic teams were made up of only paramedics, whereas physician teams were composed of a combination of physicians and paramedics. In this study, a survey was used to determine if teams had any prior experience with simulations. It found that prior experience gave rise to better team simulation performance (20).

In this section on the use of simulation for assessment, we have brought forward three important themes that were found in the literature: simulation is often only used for assessment purposes and is often limited to brief exposures, factors such as stress and the physical environment can have an impact on performance in simulations and finally, prior experience with simulation is associated with better performance on future simulations.

### **Simulation for teaching and learning**

Simulation is used for teaching and for the training of clinical skills in various healthcare student cohorts. In the United States, the most frequently reported use of simulation among the paramedic programs in 2015 was skills instruction, with 89% of programs reporting they used it for that reason, either often or all of the time (21). A 2017 survey of all the healthcare-related teaching institutions in Malaysia found that the majority considered simulation as one of their primary teaching tools, even though most of these institutions reported having less than 5 years' experience using it. Simulation was used for education, training and performance assessment of nurses, paramedics and physicians, despite the financial challenges associated with running these simulation activities (22).

In the training of military health personnel, exposure to simulation is role-dependent and is delivered by specialists in collaboration with a tertiary institution. One study conducted in 2016 gave the Norwegian Hospital Survey on Patient Safety Culture to all pre-hospital personnel in the Norwegian helicopter emergency services (HEMS) and ground emergency services (GEMS). This study (n=1107) found that HEMS personnel were generally exposed to training and assessment of simulation-based non-technical skills more frequently than the GEMS personnel. It also found that pilots and physicians were more frequently exposed to the same simulation-based training compared to paramedics, EMTs, EMT apprentices, EMT nurses and nurses (23).

In the military context, specialist educators with simulation expertise deliver simulation activities and use marking rubrics designed or taken from nursing and paramedic textbooks. In this setting, they use skill stations for practice and each student is assessed by completing a simulation scenario against a marking rubric developed through university and military co-operation (24).

Simulation provides the exposure needed to learn how to manage incidences that are rare in the field. Data analysed from 2003 to 2012 showed that the incidence of out-of-hospital cardiac arrests in Victoria was 76.7 per 100,000 adults. In this study, an 'exposure' was defined as being where a paramedic attended an out-of-hospital cardiac arrest and where resuscitation was attempted (cardiopulmonary resuscitation and/or defibrillation). The data presented in this study (Figure 1) showed that over half of the paramedics in Victoria had been exposed to an average of one out-of-hospital cardiac arrest per year of service (25).

Simulation can be used to train first responders in the management of chemical, biological, radiological, nuclear and explosive incidents. These incidents are low frequency, high impact and are only rarely encountered in clinical practice. One study reported on such a simulation where both adult and paediatric high-fidelity mannequin-based simulations were used, each with primary and secondary learning objectives (26). This paper then proceeded to report the efficacy of this approach as supported by pre and post-test scores.

### **Empirical research on the efficacy of simulation learning is sparse**

Only one paper of this type was found in the literature. In this study, 36 second-year paramedic students received the same initial didactic and mannequin airway training during their paramedic curriculum. The group was then randomly split in half where 18 students were trained in endotracheal intubation on a patient simulator and 18 were trained on human subjects in the operating room. The students that were trained on humans in the operating room completed a total of 15 training intubations. The students that used the patient simulator completed an average of 50 intubations some of which involved instruction of each basic step of intubation and repetition using various airways and

scenarios. After the training of the two groups was completed, all students were tested on 15 patient intubations in the operating room. The study found that there was no difference in both the overall success rate ( $\Delta$  3%) and first attempt success rate ( $\Delta$  4.4%) between the two groups.

In this section, which was on the use of simulation for teaching and learning, we have highlighted four important themes that have emerged from our review of the current literature. Simulation is used for multiple aspects of learning and with a range of healthcare student cohorts. In the military, exposure to simulation is role dependent and may involve collaboration with a tertiary educational institution. Simulation allows for the training of skills that are associated with events that occur rarely in the field. And finally, it appears that more work needs to be done by researchers in this field with regards to studies utilising empirical evidence. Many aspects of simulation learning in paramedicine can be tested empirically and will add to the body of knowledge in this field.

## Discussion

Our review found that there is no comprehensive method or best-practice guideline that educators can use to design and deliver effective simulations for learning in paramedicine. While there are a few studies that describe the physical aspects of simulation, these are often limited and cohort specific. It was also found that the simulation environment itself can be a place where new designs are evaluated, user data is collected and where new ideas for new and better simulators can be developed.

With regards to the use of simulation for the purposes of assessment, it was found that this was usually limited to brief exposures, factors such as stress and the physical environment

can have an impact on performance and finally, prior experience with simulation is associated with better performance on future simulations.

With regards to the use of simulation for learning in paramedicine, the literature showed that simulation is used for a range of learning and teaching purposes and with many healthcare students. In the military, exposure to simulation was reported to be role-dependent and involves tertiary collaboration. Finally, it was found that simulation allowed for the training of skills that are rarely needed in the field and that further empirical studies are needed.

## Conclusion

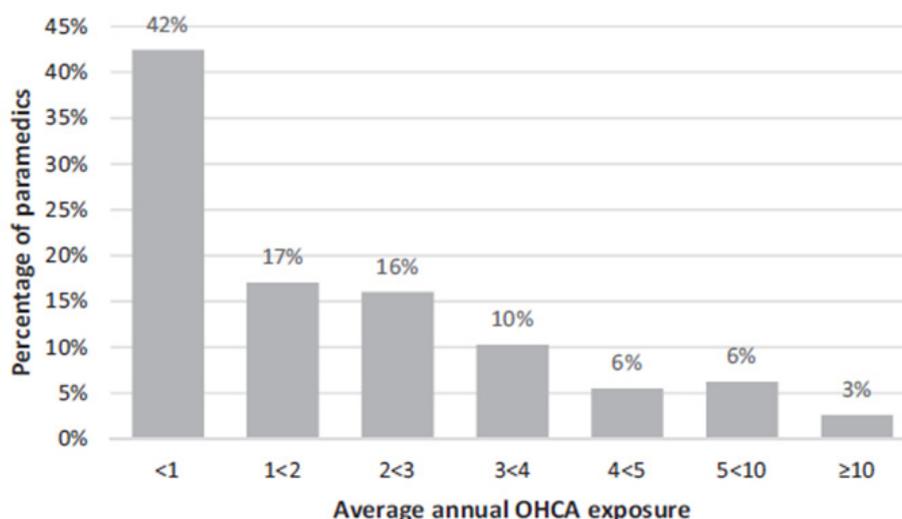
We hope that by reading this work, readers will understand the current state of knowledge in the field of simulation in paramedic education. We have provided a succinct overview of the literature and brought forward the most salient themes that emerged. We hope that other researchers will use this work to further inform and develop their simulations, not only for the purposes of assessment but also for learning and teaching in paramedicine.

## Competing interests

The authors declare no competing interests. Each author of this paper has completed the ICMJE conflict of interest statement.

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**Fig. 1.** Distribution of the average annual paramedic exposure to OHCA with attempted resuscitation in Victoria, 2003–2012.

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