



Simulation Based Education as Tool in Emergency Medicine: A Systematic Review

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Abstract: Realistic simulation is increasingly present in the academic curriculum. The traditional method of teaching is being gradually replaced by new methodological approaches, which reliably reproduce real situations and produce technical knowledge and skills in medical students in the medical emergency. The aim of this study was to carry out a systematic review of articles on realistic simulation as an educational tool in emergency medicine. A systematic review of articles on realistic simulation as an educational tool in emergency medicine, published in the corresponding period from January 1th, 2014 to October 28, 2018, was carried out in the SCOPUS database. The keywords were "simulation training", "medical students" and "emergency medicine". The research strategy resulted in 124 references. After the search for the title and summary of the citations considered for eligibility based on the inclusion criteria of the study, 106 articles were excluded, and 18 articles were retrieved and included in the final sample. The studies were distributed in 5 categories to better systematic review of the organizational quality, they are: Realistic simulation associated with the ultrasonography in the emergency; Realistic simulation and electronic devices; The effectiveness of realistic simulation in resource optimization; Impact of simulated training on student confidence; Realistic simulation as a tool in the development of skills and knowledge. This study presents the main aspects of realistic simulation as an educational tool in emergency medicine. It can be concluded that this new teaching approach has several benefits for students to learn, such as: stimulating students in the learning process, retaining technical skills in procedures, providing a safe environment for users to repeat optimization of time and financial resources.

Keywords: realistic simulation, emergency medicine, educational, systematic review

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Introduction

Simulation based medical education, using computer-operated low or high-fidelity human patient simulators or other patient models, is an established training strategy for emergency medicine.¹ In recent years, the training of resident physicians and medical students has become more diverse, voluminous and challenging. Therefore, there is a growing need for comprehensive, objective, and resource-saving educational concepts that ensure high-quality education of standardized procedures without compromising patient safety.² Simulation in medical education is discussed internationally as an effective alternative for improving knowledge, behavioral learning outcomes, as well as for technical and team skills.^{3,4}

Training programs with simulation devices have many advantages and their use is becoming more prevalent and relevant every day. Simulation-based training in the field of medicine has become the most important way of instilling safe and reproducible learning methods for students learning "*primum non nocere*" as their first base.⁵ Simulation-based education programs, which avoid the need to obtain consent, therefore have an important role to play in the preparation of medical scholars.⁶

The use of simulators as a form of instruction began in the 1920s in pilot training.⁷ They have been used in medicine over the last two decades in the field of Anesthesiology and Reanimation, which was the first specialty to use manikins extensively for residents to practice endotracheal intubation and mask ventilation.⁸ The emergency medicine quickly adopted this teaching technique^{9,10}, which gradually spread to other areas with the support of technological development and the creation of scenarios and mannequins of high fidelity capable of reproducing physiological and pathological situations.^{11,12}

This research was carried out through a systematic review and seeks to answer the following guiding question: What is the role of realistic simulation in the medical education of students enrolled in emergency medicine? Therefore, this study produces a synthesis of the main evidences of the use of realistic simulation as an educational tool in emergency medicine.

Methodology

The aim of this study was to synthesize information on the topic addressed with methodological quality, thus, in order to avoid bias in all stages of the research, a systematic

review on simulation-based education as a tool in emergency medicine was carried out. A literature search was conducted through the online Scopus database, in October 2018, and was limited to articles published between January 1th, 2014 and October 28, 2018. The reason for limiting the search between 2014 and 2018 was because in this period there was a significant growth of higher education institutions in medicine using realistic simulation as teaching method. Therefore, the simulation had great relevance in the scientific community.

Initially, MeSH descriptors (Medical Subject Headings) were used to search the Scopus database:

- # 1: "simulation training" (MeSH descriptor);
- # 2: "medical students" (MeSH descriptor); e
- # 3: "emergency medicine" (MeSH descriptor).

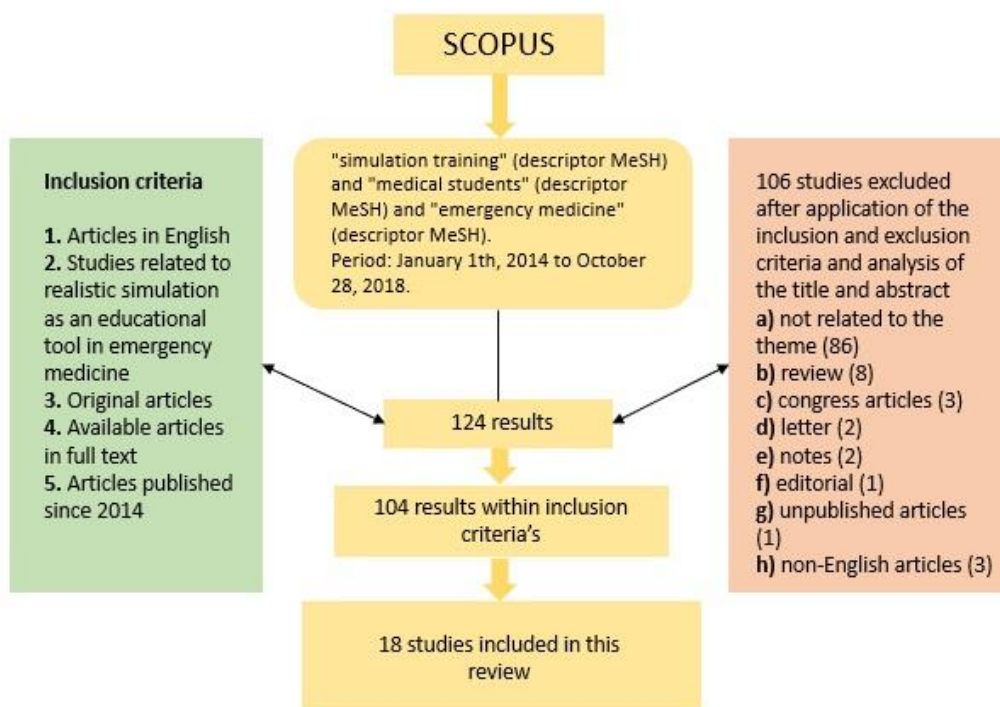
The article analysis followed pre-determined eligibility criteria. The survey was conducted in a phase 1, 2 and 3. The index used was: Title, Abstract and Keywords. We adopted the following inclusion criteria: 1) publications written in English; 2) studies related to simulation-based education as a tool in emergency medicine; 3) original articles with full text available online; and 4) articles published since of January 1th, 2014. The exclusion criteria were: 1) case reports, case series, literature reviews and comments; 2) non-original studies, including editorials, reviews, prefaces, brief communications, and letters to the editor. The articles eligible for the review were read in their entirety by 2 investigators, and the information was inserted in a spreadsheet that included authors, year of publication, description of the study sample and synthesis of the evidence. Some works found on the realistic simulation differed from the proposed theme and were not included. For a better analysis of the data, the next step involved the comparison between the articles and the division of the results obtained from the reading of each of them into five categories.

Results

Initially, the mentioned search strategy resulted in 124 references. After the search for the title and summary of the citations considered for eligibility based on the inclusion criteria

of the study, 106 articles were excluded, and 18 articles were retrieved and included in the final sample (Figure 1).

Figure 1. Flow chart showing study selection for review.



Source: The author.

The 18 studies were distributed in the five previously determined categories, as follows: Realistic simulation associated with emergency ultrasound - Eroglu; Coskun, (2018), Bentley *et al.*, (2015), Parks *et al.*, (2015) – three studies; Realistic simulation and electronic devices - Haubruck *et al.*, (2018), Karakus; Şenyser, (2014), Karakus *et al.*, (2014), Lehmann *et al.*, (2015) – four studies; The effectiveness of realistic simulation in resource optimization - Jauregui *et al.*, (2018), Parsons *et al.*, (2018), Tatli *et al.*, (2017) – three studies; Impact of simulated training on student confidence - Coughlin *et al.*, (2017), Goolsby; Goodwin; Vest, (2014), Stroben *et al.*, (2016), Watmough *et al.*, (2016) – four studies; Realistic simulation as a tool in the development of skills and knowledge - Lamba *et al.*, (2015), Miller *et al.*, (2016), Reed *et al.*, (2016), Sánchez-Ledesma *et al.*, (2016) – four studies. The categorization of the studies aimed at a better systematic review of the organizational quality. Table 1 provides an overview of all studies included in the final sample and all elements used during the data analysis process.

Table 1. Studies and main evidence.

AUTHOR	YEAR	SAMPLE	SYNTHESIS OF EVIDENCE
HAUBRUCK <i>et al.</i>	2018	95 medical students over 18 years of age from the 3rd to the 6th year of the University of Heidelberg (Germany).	The use of interactive games as educational devices is a valid and effective tool in the training of medical students for insertion of thoracic drainage.
EROGLU; COSKUN	2018	96 medical students of the 6th year who participated in the emergency service of the boarding school of the University of Kirikkale (Turkey).	The practice of realistic ultrasound simulation should last longer than 4 weeks. It provides a safe environment for the user, reduces shyness in patient analysis and increases rates of rapid and correct assessment of pathologies.
JAUREGUI <i>et al.</i>	2018	135 fourth-year medical students from the Washington University (United States).	The use of low-fidelity simulations evaluated by peers provides a cost-effective way, with efficient use of time and resources in student education.
PARSONS <i>et al.</i>	2018	14 emergency medicine students.	Simulation is an effective educational modality for teaching crisis management skills and observational simulation learning optimizes training while minimizing time and resources required
COUGHLIN <i>et al.</i>	2017	36 students (27 residents in emergency medicine and 9 medical students) who had not performed cricothyroidotomy on the day of the study.	Medical students and residents of emergency medicine felt more comfortable performing cricothyroidotomy in the emergency room after simulation with autograft in cadavers.
TATLI <i>et al.</i>	2017	63 physicians residing in emergency medicine without any theoretical or practical knowledge on the insertion of thoracic drainage at the Technical University of Karadeniz (Turkey).	The simulation model of thoracic drainage insertion can be easily used and with low cost in the training of residents in emergency medicine.
WATMOUGH <i>et al.</i>	2016	33 medical students from two hospitals in England.	The Unexpected Medical Undergraduate Simulation Training (UMUST) is an extremely popular simulation-based medical education program in which students believe it has helped them prepare for work as doctors.
STROBEN <i>et al.</i>	2016	30 medical students who completed their fifth year and were in an internship in a hospital in Berlin (Germany).	Simulation improves students' self-efficacy, which happens regardless of the role they play during training.
SÁNCHEZ-LEDESMA <i>et al.</i>	2016	300 medical students from the emergency department of the University of Salamanca (Spain).	The use of high fidelity simulators is a good alternative to complement teaching, facilitating learning, and helping medical students acquire clinical, communicative, teamwork, and response skills in neurological emergencies.

REED <i>et al.</i>	2016	135 medical students of the 4th year during the emergency caster.	Simulation-based domain learning is an effective way for medical students to learn and retain clinical skills in an emergency.
MILLER <i>et al.</i>	2016	56 third-year medical students without training in central venous access guided by ultrasound.	The use of the corpse model to simulate central venous access has been shown to be efficient in improving students' technique, as well as in the correct indications and contraindications of the procedure.
LEHMANN <i>et al.</i>	2015	57 medical students of the 3rd and 4th year at the University of Heidelberg (Germany).	The use of simulated practical training such as virtual patients demonstrated a significant increase in the performance of medical students in Basic Pediatric Life Support skills, clinical decision skills, as well as protocol knowledge and self-assessment.
PARKS <i>et al.</i>	2015	6 medical students in grades 3 and 4 and 6 resident medical practitioners in emergency medicine, both from Dalhousie University (Canada).	The use of a realistic simulation protocol with the use of Point of care ultrasound in simulated cardiorespiratory scenarios leads to an increase in the diagnostic accuracy and confidence of resident students and physicians.
LAMBA <i>et al.</i>	2015	120 medical students in the 4th year of the emergency medicine department of a large academic teaching hospital.	Simulated resuscitation and structured communication training leads to increased knowledge, comfort and competence in communicating difficult news about death and poor prognosis for the family.
BENTLEY <i>et al.</i>	2015	93 medical students of the 4th year, with similar levels of previous training in ultrasonography.	The use of FAST (Focused Assessment with Sonography for Trauma) ultrasound in simulations is not inferior to traditional ultrasound education methods using human models as demonstrated by knowledge tests, ultrasound comfort surveys, and objective examinations of student skills.
KARAKUS <i>et al.</i>	2014	48 medical students.	Computer-based simulation training would be significantly effective in learning medical treatment algorithms. These programs can improve students' success rate, especially in the appropriate medical approach to complex emergencies.
KARAKUS; SENYER	2014	29 medical students of the 6th year of Ondokuz Mayıs University (Turkey).	Computer-based medical simulation is efficient to test students' level of knowledge and increase the success rate in achieving the appropriate medical approach to emergencies. In order to save patients' lives and decrease the number of medical errors, simulation training systems should be the standard in medical education.
GOOLSBY; GOODWIN; VEST	2014	50 fourth-year medical students who were in an internship in the department of emergency medicine in Washington (United States).	The training that combines several simulation modalities increases in a statistically significant way the confidence of medical students in performing emergency medical procedures.

Source: The author.

Discussion

The use of realistic simulation has seen a substantial increase in recent years by higher education institutions in medicine. This is due to the fact that in great part there are benefits that this teaching methodology can bring to students. Several studies have been carried out by the scientific community to confirm the influence of the use of simulation in medical education learning process. The usefulness of the simulation is quite diverse, with some advantages: the increase in knowledge acquisition, the low cost of doing the method and the great stimulus of the students to carry out this method of education.

Realistic simulation associated with emergency ultrasound

The realistic simulation in the medical emergency can benefit from the use of diagnostic imaging methods, such as ultrasonography. The use of these tools does not present great differences in relation to training with human patients, thus corroborating the ideas of Bentley *et al*¹³ who undertook a prospective and controlled study with 93 medical students of the 4th year. The students were separated into two groups, in which one of them practiced the use of FAST ultrasound in human patients and the other performed the exam in simulators. The results of the study revealed through subjective and objective tests that the use of a new curriculum incorporating ultrasound simulation was not inferior to traditional methods of education using human models¹³.

In addition to that, simulation-based ultrasound devices provide a safe environment for emergency medicine students. With repeated practice performed in this safe environment, timidity, which occurs during patient evaluation, decreases, while increasing rates of fast and effective assessment of pathologies.¹⁴

The use of ultrasound simulator simplifies the educational process, in addition to improving diagnostic accuracy, confidence during simulated cardiorespiratory scenarios in the emergency room. This is consistent with clinical studies and supports the use of ultrasound during medical simulation.^{13,15}

Realistic simulation and electronic devices

Following recent technological advances of the 21st century, there were improvements in simulated training. These have been incorporated into educational curricula and have received the increase of electronic devices such as computers or so-called "serious game", an interactive game with the goal of transmitting educational content or training to the user. One of the benefits of the "serious game" is the ability to provide high levels of quality in education and medical student preparation in emergency procedures such as insertion of thoracic drains compared to traditional methods of learning.²

Computer-based simulation training appears to increase student success rates in complex emergencies such as perforated peptic ulcer, deep venous thrombosis, or organophosphate insecticide poisoning, in which the latter had success rates of diagnosis and treatment of 62.5% in students trained with simulation against 29.2% of traditionally trained students¹⁶. Computer-based medical simulation is efficient to test students' level of knowledge in procedures and increase the success rate in performing the appropriate medical approach to emergencies. In order to save patients lives and decrease the number of medical errors, next generation simulation training systems should be the standard in medical education.^{17,18}

The effectiveness of realistic simulation in resource optimization

The low amount of financial investments in several educational institutions makes the use of simulation an obstacle to the curriculum of teaching. In this way, we are looking for more and more alternatives so that there is a balance between low cost simulation model and high teaching capacity in a short period of time.

The most important problem with simulation training is the high cost. Other difficulties include maintenance expenses and problems with the organization of the training. Alternative simulation methods can be effective in teaching such an important procedure. For these reasons, new, low-cost approaches are required in the practical training of medical students.¹⁹ Parsons *et al.*²⁰ demonstrated the use of low-cost

simulations in the development of emergency crisis management skills, proving that the method is effective in the teaching process and that observational learning in the simulations is able to minimize the time and resources required.

The use of the teaching method through simulations can be used in any academic center, requiring a low investment and even so, optimizing precious resources such as teaching time and quality.²¹

Impact of simulated training on student confidence

Medical students have limited opportunities to perform procedures on living patients and may have a loss in their confidence because of this. In this way, the use of simulations can provide repeated training of students without causing harm to living patients and increase the confidence level of students. To test this hypothesis, Goolsby *et al.*²² conducted a questionnaire with 50 medical students in the emergency department of the city of Washington and reported statistically significant levels of student confidence increase immediately after the simulated training and up to 3 weeks later.

Although the training uses simulated scenarios to enact emergency situations, participants report, however, that they experienced the same anxiety level as actual situations, and the results indicate that realistic simulation helps in developing the confidence of medical students in emergencies.⁶

Simulation increases the sense of preparation in medical students. Assigning participants to different functions during the simulation is a convenient way to increase the size of the group. These roles do not negatively influence the increase in self-efficacy and provide an opportunity for the implementation of peer feedback from multiple sources. Medical trainees reflect positive reception with the use of emergency simulation and can maximize educational potential by allowing multiple participants to perform procedures from start to finish.^{23,24}

Realistic simulation as a tool in the development of skills and knowledge

Realistic simulation can be employed in the curricula of medical colleges in the emergency department, without impairing the development of knowledge and skills, but rather a considerable advance in learning methodologies. Sánchez-Ledesma *et al.*²⁵

Carried out a study with 300 medical students from the emergency department of the University of Salamanca (Spain) using a high-fidelity simulation manikin. They have reported that realistic simulation is a good alternative to complement teaching, facilitating learning, and helping medical students acquire clinical, communicative, teamwork, and response skills in neurological emergency situations. The repetition of actions in simulation scenarios facilitates the acquisition of competencies, thus justifying the implementation of simulation in learning, with the certainty that it will improve the quality of teaching in the field of medicine. This evidence meets the ideas of Reed *et al.*²⁶, who also claim to be the simulation an educational tool for medical students to learn and retain clinical skills in emergency medicine.

Besides the efficiency in the acquisition of technical skills, indication and correct contraindication of procedures²⁷, teaching with simulation can still lead to increased knowledge, comfort and competence in communicating difficult news about death and poor prognosis for the family.²⁸

Conclusion

This study presents the main aspects of realistic simulation as an educational tool in emergency medicine. It can be concluded that this new teaching approach has several benefits for students to learn, such as: stimulating students in the learning process, retaining technical skills in procedures, providing a safe environment for users to repeat optimization of time and financial resources.

With the advance of technology in the Information Era, guided by electronic devices and a connected world, the traditional method of teaching is being neglected gradually and new modalities such as realistic simulation come to add qualities to the learning processes in important health areas such as emergency medicine.

New studies and research need to be developed to meet the academic community's longing for educational methodologies that provide the confidence and the best training possible for professionals to confront the labor market or situations that require rapid and correct life-saving decisions such as medical emergencies.

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