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# Emergency medicine undergraduate simulation training during the COVID-19 pandemic: A course evaluation

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ABSTRACT

*Objective:* Reduction in patient-facing teaching encounters has limited practical exposure to Emergency Medicine for medical students. Simulation has traditionally provided an alternative to patient-facing learning, with increasing integration in courses. Rapid advancements in technology facilitate simulation of realistic complex simulations encountered in the emergency setting. This study evaluated the efficacy of high-fidelity simulation in undergraduate emergency trauma medicine teaching.
*Methods:* A consultant trauma expert delivered an introductory lecture, followed by consultant-led small group transoesophageal echocardiogram (TOE) and chest drain simulations, and a splinting station. Participants then responded to a major trauma incident with simulated patients and high-fidelity mannequins. Pre- and post-surveys were administered to assess change in delegates' trauma surgery knowledge and confidence.
*Design:* One-group pretest-posttest research design.
*Setting:* A higher education institution in the United Kingdom.
*Participants:* A convenience sample of 50 pre-clinical and clinical medical students.
*Results:* Recall of the boundaries of the safe triangle for chest drain insertion improved by 46% ($p < 0.01$), and knowledge of cardinal signs of a tension pneumothorax improved by 26% ($p = 0.02$). There was a 22% increase in knowledge of what transoesophageal echocardiograms (TOEs) measure ($p = 0.03$), and 38% increased knowledge of contraindications for splinting a leg ($p < 0.01$). The average improvement in knowledge across all procedures when compared to baseline was 35.8% immediately post-simulation and 22.4% at six-weeks post-simulation. Confidence working in an emergency setting increased by 24% ($p < 0.001$) immediately, and by 27.2% ($p < 0.001$) at six weeks.
*Conclusions:* The findings suggest that simulation training within emergency medicine can result in significant increases in both competency and confidence. Benefits were observed over a six-week period. In the context of reduced patient-facing teaching opportunities, emergency medicine simulation training may represent an invaluable mechanism for delivery of teaching.


## Introduction

The SARS-CoV2 pandemic has dramatically reduced the amount of clinical emergency medicine exposure medical students receive. This is due to efforts to protect students from 'high-risk' clinical zones as well as the fact that clinicians' workloads have dramatically increased, minimising their time available to teach. This has widened a gap in emergency medical education which may leave medical students underprepared to enter the workforce. Unfortunately, this lack of emergency medical training during medical school is a well-recognised, longstanding issue. This lack of training was in part due to the urgent nature of emergency medicine where patients are often critically ill and a delay in treatment can be life-changing [1]. These high-stakes environments may prevent students from being able to fully participate in patient care, which leads to a significant lack of experience in the field [2]. Additionally, Bligh cites McManus et al. in identifying a decline in practical clinical experience offered to UK medical students as the curriculum has made room for the increasingly information-saturated

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content [3]. It is evident that the SARS-CoV2 pandemic has accentuated an already large issue which requires innovative solutions other than in-person clinical experience.

Simulation is a potential option with the literature suggesting that it can lead to improved clinical skills [4,5], knowledge [6,7], and confidence in the ability to perform competently in an emergency setting [8]. These studies focused on the effects of simulation with various healthcare specialties, including dentistry, midwifery, caregivers, and fully qualified physicians. However, further research is needed to determine whether high-fidelity simulation can be implemented into undergraduate emergency medicine education to provide early and effective exposure to a high-risk environment that requires confidence and competence to succeed. This study evaluated the efficacy of high-fidelity emergency medicine simulation in increasing confidence and knowledge in medical students.

## Methods

The 100-minute simulation training began with a 20-minute lecture delivered by a trauma consultant covering the colour code triaging system, basic airway manoeuvres, personal and team safety, ALS (Advanced Life Support), and SALT (Sort, Assess, Lifesaving interventions, Treatment/Transport). 50 pre-clinical and clinical medical students were divided and rotated through four 20-minute emergency simulations: fracture splinting, chest drain insertion, transoesophageal echocardiogram (TOE), and a simulated major incident scene. The simulations were led by trauma, emergency medicine, and anaesthetic consultants, with trained junior doctors and members of the student surgical society committee assisting as facilitators. Students were unaware of the course content prior to the simulations. They practised the simulated skills under guidance of the consultants and the relevant indications and contraindications of each simulated skill were discussed.

The simulated major incident scene required students to 'enter the scene' as first responders and triage nine patients (five high-fidelity simulators and four actors) according to the colour code triage system and perform any immediate lifesaving treatment required. The trauma scene included five high-fidelity mannequins programmed with the following pathologies: a patient with an obstructed airway (requiring immediate intervention), a pregnant patient with a tibial fracture, a patient with a pneumothorax, and two dead patients. The actor patients' conditions included: a head injury (GCS 8), smoke inhalation, panic attack with a first-degree burn, and an open fracture of the femur. The students were then debriefed by an emergency medicine consultant and their triage and management choices were discussed.

This study is in accordance with the Declaration of Helsinki and all students provided voluntary informed consent and no identifiable information was collected.

### *Statistical analysis*

To evaluate the short- and long-term efficacy of the simulation training, 5-point Likert scale surveys pertaining to the students' confidence and knowledge around emergency medicine were administered before, immediately after, and six-weeks after the training. Answers were converted to a percentage of possible confidence and were analysed for statistically significant changes using unpaired Student's T-tests.

The surveys contained space for students to write their answers to five knowledge questions and the changes between surveys were determined by marking the students' answers using a predetermined mark sheet. Statistically significant changes in the number of correct responses in each survey were determined using Chi-square significance tests. P-values $< 0.05$ were considered statistically significant and descriptive studies are used to display results.

## Results

A total of 50 pre-clinical and clinical medical students participated in the simulation. 50 students (100%) responded to the pre-simulation survey, 43 students (86%) responded to the immediate post-simulation survey, and 36 students (72%) responded to the 6 week post-simulation survey. All surveys were anonymous and voluntary.

### *Confidence*

All students reported a significant increase in confidence immediately post-simulation with confidence retention six weeks post-simulation in all skills assessed (see Table 1). The average increase in confidence immediately post-simulation across all skills was 33.3% from baseline. At six weeks post-simulation, students still reported an average confidence increase of 33.1% across all skills. Confidence in splinting fractured legs demonstrated the greatest improvement, with an average increase of 50.8% ($p < 0.001$) immediately post-simulation compared to baseline. At six-weeks post-simulation, students still expressed a 41.7% ($p < 0.001$) confidence increase from their baseline at splinting fractured legs. The skills that showed the least amount of confidence improvement were using the SALT triage system and the ALS approach. They demonstrated a 23.0% ($p < 0.001$) increase in confidence immediately post-simulation and interestingly, students reported more confidence with the skills six weeks post-simulation, with a confidence increase of 37.2% ($p < 0.001$) and 36.7% ($p < 0.001$), respectively. All students agreed that high-fidelity simulation was an effective method of teaching emergency medicine.

### *Knowledge*

The results demonstrated that the simulation led to a significant knowledge increase of all emergency procedures assessed (see Table 2). The average improvement in knowledge across all procedures was 35.8% immediately post-simulation when compared to baseline. At six-weeks post-simulation students demonstrated an average knowledge increase of 22.4% across all procedures when compared to baseline. Knowledge of chest drain indications demonstrated the greatest improvement in knowledge with an average increase of 47% ($p < 0.01$) immediately post-simulation compared to baseline. At six weeks post-simulation students expressed an 18% ($p < 0.01$) increase in knowledge of chest drain indications from their baseline.

The skill that showed the least knowledge improvement immediately post-simulation, later demonstrated the greatest knowledge increase six weeks post-simulation. Students' knowledge of what a transoesophageal echocardiogram (TOE) measures increased 22% ($p = 0.03$) immediately post-simulation compared to baseline, at six weeks post-simulation there was a 38% ($p < 0.01$) increase in knowledge compared to baseline.

During the trauma scene simulation, the students correctly triaged 72% of the patients (95% CI [63.9%, 80.1%]) using the colour triage system and on average took 25.8 s (95% CI [5, 46.6]) to recognize and safely secure an obstructed airway.

## Discussion

The results from our simulation demonstrate the value of high-fidelity simulation and affirm its place in medical education, in the novel context presented by SARS-CoV-2. Clinical knowledge

**Table 1**
Averages of students' confidence increase for different skills calculated from the Likert scale surveys using unpaired Student's T-tests between the baseline (pre-simulation survey) and the immediate post-simulation survey or the 6-week post-simulation survey.

| **Parameter Evaluated** | **Improvement Immediately Post-Simulation [95% CI]** | **P - Values** | **Improvement 6 Week Post-Simulation [95% CI]** | **P - Values** |
|---|---|---|---|---|
| Confidence splinting a fractured leg | 50.8% increase [43.5%, 58.0%] | $p < 0.001$ | 41.7% increase [32.2%, 51.2%] | $p < 0.001$ |
| Confidence using the colour system (black, red, yellow, green) approach for triaging patients? | 45.1% increase [37.3%, 53.0%] | $p < 0.001$ | 33.3% increase [24.2%, 42.5%] | $p < 0.001$ |
| Confidence performing a transoesophageal echocardiogram (TOE)? | 43.1% increase [37.4%, 48.7%] | $p < 0.001$ | 33.9% increase [26.2%, 41.6%] | $p < 0.001$ |
| Confidence evaluating which patients are stable to transfer to hospital from the incident scene? | 38.5% increase [31.3%, 45.7%] | $p < 0.001$ | 33.3% increase [24.2%, 42.5%] | $p < 0.001$ |
| Confidence inserting a chest drain? | 35.9% increase [26.4%, 45.4%] | $p < 0.001$ | 34.4% increase [26.6%, 42.3%] | $p < 0.001$ |
| Confidence in ability to assess the suitability of a chest drain? | 32.3% increase [24.2%, 40.4%] | $p < 0.001$ | 35.0% increase [26.9%, 43.2%] | $p < 0.001$ |
| Confidence assessing your team safety at the scene of a traumatic incident? | 32.3% increase [24.1%, 40.5%] | $p < 0.001$ | 32.8% increase [23.6%, 42.0%] | $p < 0.001$ |
| Confidence performing basic airway maneuvers? | 28.2% increase [18.7%, 37.7%] | $p < 0.001$ | 27.2% increase [16.4%, 38.1%] | $p < 0.001$ |
| Confidence working in an emergency medical setting? | 24.0% increase [17.7% - 31.5%] | $p < 0.001$ | 27.2% increase [18.6%, 35.8%] | $p < 0.001$ |
| Confidence assessing airway patency? | 23.1% increase [13.5%, 32.7%] | $p < 0.001$ | 24.4% increase [13.5%, 35.4%] | $p < 0.001$ |
| Confidence using the A.L.S. approach? | 23.0% increase [14.8%, 32.4%] | $p < 0.001$ | 36.7% increase [26.9%, 46.4%] | $p < 0.001$ |
| Confidence using the S.A.L.T. approach? | 23.0% increase [14.2%, 31.9%] | $p < 0.001$ | 37.2% increase [27.5%, 47.0%] | $p < 0.001$ |

Footnotes: A.L.S. = Advanced life support, S.A.L.T. = sort, assess, lifesaving interventions, treatment and/or transport.

**Table 2**
Averages of students' knowledge improvement for different skills calculated from the immediate post-simulation survey and 6-week post-simulation survey, each compared to baseline (pre-simulation survey).

| **Parameter Evaluated** | **Improvement Immediately Post-Simulation (P - Value)** | **Improvement 6 Week Post-Simulation (P - Value)** |
|---|---|---|
| Knowledge of indications for administering a chest drain? | 47% (<0.01) | 18% (<0.01) |
| Knowledge of the boundaries of the safe triangle for inserting chest drain | 46% (<0.01) | 28% (0.05) |
| Knowledge of contraindications for splinting a fractured leg? | 38% (<0.01) | 12% (0.47) |
| Knowledge of cardinal sign of a tension pneumothorax? | 26% (0.02) | 16% (0.05) |
| Knowledge of what a transoesophageal echocardiogram (TOE) measures | 22% (0.03) | 38% (0.01) |

and confidence are essential attributes for the provision of excellent clinical care; it is thus promising to see that our participants' knowledge and confidence were both significantly improved following our simulation, immediately and after 6 weeks.

Other simulation studies have achieved similar results. One which took place at the University of Michigan Medical School reported increased confidence and skills in medical students who participated [2]. Another simulation involving healthcare professionals across 7 emergency departments throughout Seattle, Washington showed increased participant confidence in 2 h [8]. The Trauma Evaluation and Management course designed by the American College of Surgeons demonstrated retention of skills in performing a primary survey at 1 year at the Medical College of Wisconsin [9], and retention of trauma knowledge at 6 months in sixth (senior)-year medial students at the University of Cape Coast, Ghana [10].

In institutions where this is feasible, there is scope for expansion of our simulation course to incorporate specialist knowledge from a multi-disciplinary team faculty. For example, maxillofacial surgeons could provide teaching regarding facial trauma, orthopaedic surgeons regarding definitive trauma care, and anaesthetists for the basics of care in the intensive care unit.

An important limitation to our study includes loss to follow-up of 7 students (14%) for the immediate post-simulation survey, and 14 students (28%) for the 6 week post-simulation survey. This may have had an impact on the results through non-response bias, for example if those who did not respond were systematically less engaged or interested in the simulation, and so may have had lower post-simulation confidence levels or knowledge scores.

## Conclusion

In the context of a global pandemic, where patient-facing teaching opportunities are limited for medical students, simulation within emergency medicine can provide significant learning benefits. Our results demonstrate significant increases in confidence and knowledge in performing under stress in emergency situations that are sustained after six-weeks. Within the movement towards a blended approach to the delivery of medical education, simulation in emergency medicine should be considered in the design of undergraduate medical courses.

## Ethics statement

Ethical approval was not required for this study. All participants provided full consent to participate in the study.

## Authors' contributions

All authors contributed to data analysis, drafting and revising the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

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## Declaration of Competing Interest

The authors have no conflicts of interest to declare.

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