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Intermediate Fidelity Simulation to Educate Emergency Management Skills

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ABSTRACT

Medical students learn clinical skills related to the management of emergencies during their clerkships, mainly via peripheral participation and observation. Simulation-based training is identified as an adjunct to clinical practice enabling students to learn clinical skills in a safe environment. Nevertheless, simulation-based training is still underutilised in many countries in the developing world. The purpose of this study was to explore the value of simulation-based learning using an intermediate fidelity simulator to train medical undergraduates on the management of medical emergencies. A pilot group of 80 fourth year medical students attended four simulation-based clinical skills sessions. The students completed a self-administered evaluation, which included both open and close-ended questions post-simulation. Descriptive statistics were employed to analyse the responses to close-ended questions, and the responses to open-ended questions were analysed for recurring themes. All participating students responded to the evaluation. Students rated the simulation-based learning experience with high positivity. The self-competency of 74 (92.5%) students had increased following the sessions. The sessions have provided a "safe" learning environment to all students, and 70 (87.5%) felt it helped apply theory into practice. Thirty-three (41.2%) noted the simulation session as an important learning tool for practising clinical skills. Thirty-one (38.5%) wished to participate in more sessions, and 39 (48.7%) felt that simulation should be introduced to the curriculum from the first-year. Students have recognised intermediate fidelity simulators as a valuable learning tool to train on the management of clinical emergencies and should be integrated into undergraduate medical curricula.

Keywords: *Simulation, Medical students, Intermediate fidelity, Self-competency*

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INTRODUCTION

A graduating doctor is expected to be competent in the management of common medical emergencies during their internship/ foundation year (1). However, there is ample evidence globally, that graduating clinicians are far from competent in the management of emergencies during their internship period (2, 3).

Medical students develop clinical skills related to the management of emergencies by rotating between various clinical clerkships through which students are expected to gain the required level of clinical competence. However, in the management

of emergencies, medical students' exposure is limited to being peripheral observers. The management of emergencies is mostly confined to theoretical classroom-based teaching, reading and tutorials (4), which is the maximum possible for providing the optimal patient care but far from the ideal in an educational perspective. The unpredictable occurrence of emergencies and the ethical dilemmas associated with allowing medical students to learn from critically ill patients hamper the accessibility of medical students to involve in the management of medical emergencies. As simulators are available at all times unlike real patients and as clinical scenarios can be repeated on demand, simulation provides a standardised learning experience where the students can learn by trial and error, without risk to neither patient nor the student (4–6). Researchers, therefore, have explored the place of simulation to facilitate medical undergraduates to learn clinical skills related to the management of common medical emergencies.

Currently, simulation is widely employed globally in training healthcare professionals, including medical undergraduates (5, 7, 8). In undergraduate curricula, training students using high fidelity simulators were very successful as it encourages the provision of feedback (4, 9). Simulation has also been recognised as an effective educational strategy to reduce medical errors, particularly in the management of medical emergencies (10, 11). The literature provides convincing evidence on the role of simulation-based learning in improving knowledge and skills of learners in the management of emergencies (7, 12).

Despite clear evidence of the benefits of incorporating simulation in medical education, developing countries like Sri Lanka has lagged behind the developed nations in incorporating simulation-based learning in undergraduate medical curricula. This could well be due to high costs associated with high-fidelity simulators (13). Therefore, the possibility of enabling students to reap benefits of simulation-based learning with the use of low-cost simulators is worth looking into, especially in countries like Sri Lanka.

We evaluated the place of low cost, instructor-driven, intermediate-fidelity simulator-based training in developing the skills of managing medical emergencies among medical undergraduates in Sri Lanka.

METHODS

Study Population and Sampling Procedure

The simulation-based training on the management of medical emergencies was piloted among 80 volunteering fourth-year medical students at the clinical skills centre of the Faculty of Medicine, University of Kelaniya from July to October in 2018 after obtaining informed consent. A convenience sampling method was used. The participants had already undergone eight-week clerkships in medicine, had attended the emergency treatment unit, medical wards and lectures in management of common medical emergencies before the commencement of the simulation sessions. Before the simulation session, students were reassured that they were not expected to perform beyond their abilities and that their performance would not affect their assessments.

Study Tools

An intermediate fidelity simulator consisting of a full body mannequin (Shanghai Hongligan Medical Technology Group Co. Ltd., Shanghai, China) and instructor driven responses was used in the study which differs from computer-driven high fidelity simulators complete with automated responses (14).

Intervention

The students initially underwent a period of familiarisation with the simulator and the equipment. Four medical emergencies were presented to the students: haematemesis, anaphylaxis, acute severe asthma and cardiac arrest. These four scenarios were chosen from

the topics in the taught curriculum of the Faculty of Medicine, University of Kelaniya, as these are common medical emergencies seen in the ward setting, which have been utilised for simulation training in similar studies (2, 4, 11, 15). Following selection of the scenarios, a list of actions was created for each scenario and revisions were made according to comments from clinicians. The scenarios were then designed and scripted with further inputs from clinicians to require immediate action within five-minutes of the initiation of the scenario. The students were presented with the problem by the facilitator. The students were given time to plan their responses as small teams of six to eight students where they divided the roles each among themselves, allowing less competent students to take minor roles. The students were given two hours per scenario. The facilitator observed while the teams managed each emergency. The facilitator assisted the students when in need, acting as a nurse, thereby preventing inappropriate treatment or prompting initiation of necessary treatment. This prevented simulator death, which could be stressful for the students and could affect the learners negatively.

The scenarios were followed by a debriefing session where the students clarified any concerns. The debriefing session was aimed to be a constructive and supportive. Students were encouraged to reflect and identify their strengths and areas of improvement.

Data Collection

The students responded to a paper-based self-administered evaluation post-simulation which was developed by the researchers based on previously published articles (2, 15, 16). The questionnaire included two parts: Part 1 included items on student perceptions on the simulation-based training activity using a rating scale from 1–5 (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree). The items explored the safety of the learning environment, working as a team, improvement in self-confidence to manage similar situations during practice, application of theory into practice, improvement in knowledge and skills on managing medical emergencies and overall views on simulation-based training. Students also rated their level of confidence in dealing with medical emergencies before and after the simulation-based learning session on a scale of 1–5, where 1 = beginner and 5 = master; Part 2 of the questionnaire included open-ended follow-up questions with general written comments to generate qualitative data on students' opinion on the use of simulation-based learning in their education.

Statistical Analysis

The data gathered from the closed-ended questions of the evaluation were analysed using descriptive statistics. The data were analysed using SPSS software version 22. Data were presented as percentages and means. A p-value of < 0.05 was considered statistically significant. The open-ended questions were coded and analysed for recurring themes.

RESULTS

All 80 students responded to the evaluation. Students rated the simulation-based learning session very positively and found it a valuable learning experience (Table 1). The students felt safe in the simulated learning environment where they were encouraged to apply theory into practice.

Seventy-four (92.5%) students reported an increase in their self-competency about the management of medical emergencies following the simulation-based learning session. Thirty-four (42.5%) students felt their competency level increased from Level 2 to Level 3 while 17 (21.2%) students felt their competency level increased from Level 1 to Level 3 as shown in Table 2. The mean increase in competency was 1.2, which was statistically significant ($p < 0.001$). Fifty (62.5%) students felt the competency level increase by one level and 24 (30.0%) students reported an increase in self-competency by two levels.

Table 1: Responses to the questionnaire

Question	Median	Inter-quartile range (IQR)	Range
a. Was the learning environment safe?	4	4–5	4–5
b. Were you encouraged to work as a team?	5	4–5	4–5
c. Did the session improve your confidence to participate in the clinical setting?	4	4–5	4–5
d. Did the session helped you to put theory into practice?	5	4–5	4–5
e. Did the session improve your knowledge on management of medical emergencies?	4	3–4	2–4
f. Did the session improve your skills on management of emergencies?	4	4–5	4–5
g. Was the simulation session a valuable experience?	5	4–5	4–5

Note: The score ranges from 1–5 (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree)

Table 2: Change of competency levels after simulation-based training

Competency level before	Competency level after n (%)			
	1	2	3	4
1 (N = 31)	2 (6.4%) (unchanged)	12 (38.7%)	17 (54.9%)	0
2 (N = 44)	0	3 (6.8%) (unchanged)	34 (77.2%)	7 (16%)
3 (N = 5)	0	0	1 (20%) (unchanged)	4 (80%)
4 (N = 0)	0	0	0	0

Note: The score ranges from 1–5 (1 = beginner, 5 = master)

Table 3: The students' opinion on the use of simulation in undergraduate medical education

Written comment groupings		Student responses	
		Number	Percentage (%)
Overall assessment	Interesting	56	70.0
	Useful	42	52.5
Theory into practice	Hands on experience	26	32.5
	Good practice	44	55.0
Teaching utility	Useful learning tool	33	41.2
	Encourage learning	25	31.2
	Promote team work	23	28.7
Future goals	Need more sessions	31	38.7
	Make it mandatory	10	12.5
	Start from first year	39	48.7

Seventy-four students responded to the open-ended questionnaire with a response rate of 92.5%. With regard to the use of simulation in undergraduate medical curricula, respondents were positive. Many students expressed that simulation helped them to apply theory into practice (typified by the comments "can have hands-on experience" and "gave an opportunity to practise". Students also felt that they should have more simulation sessions in the curriculum, and they should start simulation-based learning sessions from the first year onwards "to get the feel of being a doctor". The qualitative analysis of the medical students' written reactions is reported in Table 3.

DISCUSSION

The students took the clinical decisions, planned and carried-out treatments by themselves during the simulation-based training session. This experience was rated by students as a valuable experience. The students' comments emphasised that they were encouraged to apply theoretical knowledge to practice and valued a safe environment where they could practice their skills. They valued the opportunity provided by the simulated environment where they could manage an emergency without causing patient harm. The students found the simulation-based training as a good opportunity to practice reflected by the high percentage of students who identified good practice as an advantage of simulation-based training. Students worked on their "patient" in small teams and reflected on the performance of their team. Therefore, they learned the importance of teamwork in the management of emergencies. Students felt their self-assessed competency improve with simulation-based learning session and appeared to have an increased level of confidence to deal with medical emergencies. They wanted more exposure with simulation-based learning sessions and felt they should start simulation sessions early in the undergraduate curriculum. Simulation-based learning allows students to actively engage and learn through practice in a non-threatening environment aided by reflection and feedback. Simulation helps students to learn from their own mistakes and each other. It helps students to improve both knowledge and skills, complying with similar studies (2, 15).

The ultimate goal of a medical curriculum is to produce a competent clinician upon graduation. Traditional didactic methods of teaching are insufficient in achieving the desired learning outcomes about the management of emergencies. Only clinical exposure to the medical emergencies can render adequate training on management of acutely ill patients, which is easily addressed by simulation, which may fill a gap in the current undergraduate medical curricula (6, 17, 18). Studies conducted previously among medical students have found that students value simulation-based learning highly (4, 9). Our study confirmed their findings and confirmed that the positive attributes of simulation-based medical education transcend different institutions and countries across the world.

This study differs from the rest as previous studies have been conducted using high-fidelity and medium-fidelity simulators. McGaghie et al. (19) points out the significance of researching to assess the level of simulator fidelity required to achieve learning outcomes. Although high-fidelity simulators are undoubtedly valuable as models to learn the management of emergencies where changes in physiological parameters can be observed in real-time (20), the present study demonstrated similarly high levels of satisfaction among the students as observed in the above studies with the use of a much less expensive instructor driven intermediate-fidelity simulator. This emphasises the feasibility of using low technology, low-cost simulators effectively and satisfactorily in undergraduate medical curricula. This is of importance specially in developing countries such as Sri Lanka, where high fidelity

simulators are costly and an unaffordable method of education.

This study was limited to students' opinion and self-assessments. It is possible that the self-rating scores may increase due to novelty of the simulator and the simulated learning experience. Therefore, we attempted to minimise this effect through a period of familiarisation with the simulators prior to the scenarios. Increased student exposure to simulation could address this problem, but were not feasible within the time constraints of the student curriculum. Although an increase in self-confidence and self-assessed competence was demonstrated in this study, a randomised, controlled trial with appropriate outcome measures could provide objective evidence to support simulation-based learning among medical undergraduates.

However, the current study demonstrates that medical undergraduates valued the simulation training experience in the domain of emergency management. The intermediate fidelity simulator used in this study is only a fraction of the cost of a high fidelity simulator, despite the students showing similar levels of satisfaction. This study imparts that low cost simulators can be utilised satisfactorily for undergraduate education. Therefore, we recommend the use of intermediate fidelity simulators for undergraduate medical education, especially for resource poor countries, where simulation-based education is understood as an unaffordable method of education.

CONCLUSION

Medical students value simulation-based learning as a useful educational experience. Simulation-based learning allows students to practice in a safe learning environment and provides an opportunity to integrate theoretical knowledge and practice while improving both self-confidence and competence. An instructor-driven intermediate-fidelity simulator can be used effectively in undergraduate medical education in resource-poor countries such as Sri Lanka.

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