High-fidelity simulation training programme for final-year medical students: implications from the perceived learning outcomes

YF Choi *, TW Wong

ABSTRACT

We designed a session of high-fidelity simulation training course for final-year medical students in their emergency medicine specialty clerkship. This was a new initiative with clearly defined learning outcomes. We aimed to evaluate the learning outcomes. Students completed an evaluation form at the end of the session focusing on their perceived learning outcomes. Thematic analysis was conducted for data processing. We collected responses from 149 students. In addition to the intended outcomes of the course, students gained unexpected learning outcomes from the training and some of them matched a few identified learning gaps between undergraduate medical education and their subsequent transition to early clinical practice that have been described in the literature. High-fidelity simulation training in medical school could be an effective tool to address some of the identified gaps in the transition between undergraduate medical education and postgraduate practice.

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Introduction

Clinical simulation training has become more widely practised in local hospitals and academic healthcare institutions in the past decade, with a wide range of training modalities, from part-task simulator to full-body manikin and from single skill training to interprofessional team-based training.

The Nethersole Clinical Simulation Training Centre is a hospital-based training centre which has advocated high-fidelity multidisciplinary team training for hospital staff since its establishment in 2012 in Pamela Youde Nethersole Eastern Hospital. From 2008, the emergency department of the hospital was one of the centres for teaching emergency medicine specialty clerkship medical students from one of the medical schools in Hong Kong. In 2017, the emergency department collaborated with the Nethersole Clinical Simulation Training Centre in an initiative to design a high-fidelity simulation training session for medical students.

In the past, medical students in local medical school did not have much high-fidelity simulation training because medical schools did not have high-fidelity training facilities. Furthermore, it was conventionally believed that high-fidelity simulation training is more beneficial for expert-level learners and that low-fidelity training was more suitable for beginners, because the sophisticated context in the high-fidelity environment might potentially jeopardise learning objectives by creating excessive cognitive burden.[1-3] Medical students, owing to their low clinical exposure, were regarded as beginners.

However, a recent study suggested that once medical students have learnt some basic skills, high-fidelity simulation training might benefit learners through psychological immersion, despite the extra cognitive burden.[4] Therefore, we decided to trial high-fidelity simulation training for final-year medical students, who have already completed most of their academic studies and have acquired some basic practical skills.

The prototype of the simulation training course was started in 2017 and at that time we mainly evaluated the "reaction" phase of the learners which is the basic level of outcome evaluation according to Kirkpatrick's model (Fig). The feedback from the students was very positive and they welcomed the course very much.[5] Encouraged by this, we revised the course material in 2018 with written intended learning outcomes. In the present study, we evaluate "learning", which is a level higher in the Kirkpatrick's model.

The aim of the present study was to evaluate the learning outcomes of a high-fidelity simulation training course for final-year medical students.

Methods

Design

This was a qualitative study by a survey in English. The contents were checked against SRQR reporting

guideline (Standards for Reporting Qualitative Research 2016 version).

Setting

The training course was conducted in the Nethersole Clinical Simulation Training Centre that has a simulation training suite with isolated simulation rooms and a debriefing room. The simulation rooms are equipped with ceiling-mounted cameras for video-assisted debriefing. The simulation room used was prepared to resemble the environment of a resuscitation room in the emergency department with a full-body high-fidelity manikin.

Course design

The training course consisted of a brief introduction followed by four short case scenarios in a 3-hour session. In the introduction, students were briefed about course structure, learning objectives, and clinical simulation rules and underwent a short simulation laboratory familiarisation session. A group of seven to eight students further divided into two subgroups played the four scenarios in turn. While one subgroup was doing the scenario, the other subgroup observed from the debriefing room via the audio-visual system. The instructor wore a nurse uniform and acted as an experienced nurse in the scenarios, which included no real-time coaching. In the four scenarios all the patients presented with acute or even life-threatening conditions that need prompt treatment. Such a design simulated the high psychological fidelity of real life. Participants had to treat the patients on their own with no guidance from the instructor. A debriefing session was carried out immediately after each scenario.

Data collection

A cohort of student participants in 2018 were selected by convenience sampling and they were asked to complete an evaluation form immediately after the session. The evaluation form invited the students to offer free text only with no rating scale. They could write up to three perceived learning outcomes, up to three reflections after the course and any extra comments or suggestions about the course. There was no space to enter the name of the students, so the data collection was completely anonymous.

Data analysis

The findings in the evaluation form were processed through thematic analysis shortly after each course and compared with the intended learning outcomes of the course (Table 1). The intended learning outcomes were designed to include both clinical learning outcomes and teamwork learning outcomes such as briefing, debriefing, communication, situation awareness, and leadership. The clinical learning outcomes, owing to their diversity were further divided into three separate categories (general approach to critical patients, use of investigations and resuscitation skills) while all the teamwork-related learning outcomes are grouped under one category. The written learning outcomes were first coded under these intended learning outcomes. Items not fitted under the intended learning outcomes were considered new findings. These new findings were further processed newly identified themes. The results of thematic analysis were checked serially by the authors for quality assurance. Consensus on new themes after further literature review was made between authors on items that could not be categorised under the intended learning outcomes.

六年級醫科生參與高度模擬培訓課程：感知學習成效所帶來的影響

蔡宇暉、黃大偉

慨述六年級醫科生於急症科見習時參與高度模擬培訓課程。這項新舉措具明確學習成效，而本文旨在評估他們參與課程後的學習成效。學生在培訓課程後填寫針對感知學習成效的評估表，以專題分析處理數據。我們共收集149名學生的回覆。除了預期成效，學生還取得意想不到的學習成果，部分與文獻描述的醫學本科教育過渡至早期臨床實踐的已知學習差距相匹配。作者認為醫學院的高度模擬訓練可以有效填補醫科生於醫學本科教育與臨床實習過渡期間的部分已知學習差距。

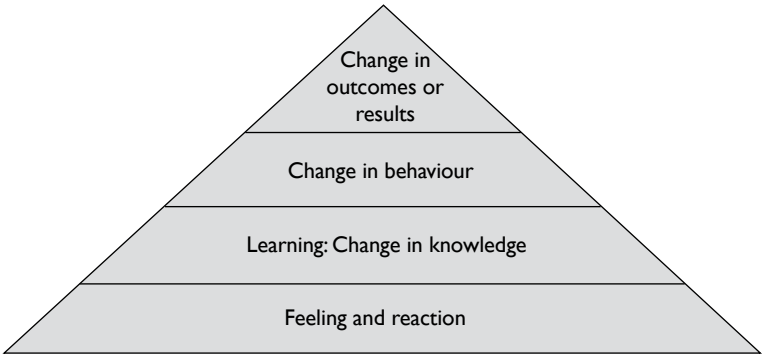

FIG. Kirkpatrick model of course evaluation (evaluation training programmes. 1975)

Results

Data saturation was attained after 20 sessions with 149 evaluation forms collected (data saturation is a point when no new theme was found by thematic analysis after analysing the responses after several courses). The response rate was 100% and more than 99% (148 out of 149) of the returned forms

were complete, despite the voluntary nature of data collection.

The intended learning outcomes are listed in Table 1. From the contents of the evaluation form, all of the intended learning outcomes were well received by the respondents, as reflected by the responses shown in Table 1.

In addition to the intended learning outcomes, we discovered a large number of learning points or reflections that cannot be categorised under our pre-planned learning objectives. These additional unexpected learning points were processed by thematic analysis under new headings as listed in Table 2.

Respondents were also given the opportunity to make open comments or suggestions about the course. Some of the responses are listed in Table 3.

Discussion

The original intention of course evaluation questionnaire was to evaluate the learning objectives as perceived by students. The results suggest that our intended learning outcomes were well received by our students. A number of learning outcomes were revealed that did not fall into our intended learning outcomes by thematic analysis. Additional literature review revealed that these unexpected outcomes match some gaps identified in the transition between undergraduate medical education and postgraduate practice.

TABLE 1. Intended learning outcomes of the course with sample quotations from respondents

Intended learning outcomes	Representative sample quotations from respondents
1. Practise systemic approach to patients with critical condition	• "…learned a systemic approach to a critical patient in an unfamiliar setting started with little information." • "…have practised how to see a patient with conditions like…" • "…in XXX emergency situation, know what treatment should be prioritised."
2. Gaining an initial understanding of teamwork in managing critical patients	• "Teamwork and communication are as important as book knowledge." • "Briefing before going in is very helpful." • "I learned the importance of leadership and how to be a responsible member of the team." • "SBAR is a good model of handling information." • "More communication among team members is important."
3. Practise basic resuscitation skills and therapy	• "It is a good chance to let me practise ACLS guidelines and do electrical therapy." • "Life-threatening condition should be identified early." • "Learned how to put learned resuscitation knowledge into real practice." • "History, physical exam, investigation and treatment can all be carried out at the same time instead of in sequence."
4. Familiarise with common investigations for critical patients	• "I learned how to use and interpret various investigations in emergency patients." • "A good practice to interpret ECG and X-ray in real life." • "I learn about how to resuscitate the patient and do investigation at the same time." • "Knowing about what and why for investigations."

Abbreviations: ACLS = Advanced Cardiovascular Life Support; ECG = electrocardiogram; SBAR = Situation-Background-Assessment-Recommendation)

TABLE 2. Unexpected/additional learning outcomes from the course with sample quotations from respondents

Additional learning outcomes	Sample quotations from respondents
1. Understand that work under stress in real life is totally a different experience	• "I learned that we should remain calm and not brain-freezing when facing emergency situation." • "It is much easier to be an observer than being put into real scenario when quick decision has to be made." • "It gave us an experience of work under stress and make instant decision on patients." • "I recognised that there was knowledge-action gap in the scenario…" • "Book knowledge and real practice are so different!"
2. Simulation allow one to identify own weakness in learning	• "Essential practical points may be forgotten, such as check pulse." • "Simulation is useful for me to realise my knowledge gap." • "I thought I know the bookwork but actually I need to do more revision."
3. Discuss about situation awareness for patient safety when encountering uncertainty	• "Never be too brave. And know my limitation." • "Trust nurse colleagues and consult senior if necessary for patient safety." • "Don't be afraid to tell what you think when identify a problem." • "Need to avoid single-tract mind way of thinking and consider all the possibilities." • "I should be able to voice out when I suspected my colleague committed a mistake." • "Head-down work will affect situation awareness."
4. Dealing with acute patients	• "I should be familiarised with management of life-threatening conditions." • "Feel anxious with critical patients."
5. Difficulties in prescribing	• "We must ask allergy before giving drug." • "I should be familiar with the use and dosage of some essential resuscitation drugs."

TABLE 3. Selected additional open-ended comments or suggestions on the course from respondents

"The simulation experience was highly valuable and enhanced my understanding tremendously."
"Helpful and fun. It helps us to translate book work into practical skill. It is great in not giving us hint during the scenario and teach us afterwards."
"The previous ACLS teaching by XXX department was not as fruitful as this simulation session."
"It is one of the best sessions I ever have. We can apply our knowledge in managing patients in urgent situation."
"We seldom have chance to have this kind of real practice is medical school. It is practical and inspiring!"
"It is a very good mental exercise in preparing for real life emergency situations. It helped us reflect on our weakness and improve by further exercise and revision."
"A good experience to learn from own mistake."

Abbreviation: ACLS = Advanced Cardiovascular Life Support

Fidelity

In our training course, high fidelity was thought to be an important element to achieve the learning outcomes, including the unexpected ones. Fidelity is commonly defined as "the level of realism present to the learners during a simulation training".[3,4] Conventionally, it is believed that higher fidelity leads to more efficient learning.[6]

However, fidelity is not a single-dimensional concept and there are different components of fidelity described in the literature using different terminology. For simplicity, we consider the definition of fidelity described by Feinstein and Cannon, in which fidelity of simulation has physical and functional aspects.[3] Physical fidelity includes the environmental, visual, and spatial components, such as the design of the simulation room, the performance of manikin, and the settings of various instruments. Functional fidelity is a dynamic interaction between the participants and their task, including information, stimuli, and responses of learners. Other simulation educators have used the terms "conceptual", "experiential", "emotional" or more commonly "psychological" fidelity to describe the same or similar concepts,[2,7] but further discussion is beyond the scope of the present study.

High-fidelity simulation training was not always regarded as superior to lower-fidelity training. Besides the issue of cost, early studies in the last century in various disciplines (such as civil and military aviation) failed to show better learning outcomes after high physical fidelity training.[3,8-10] This might be because the high physical fidelity training over-stimulated novice learners and resulted in cognitive overload that jeopardised the intended learning objectives.[11] Such findings supported the conventional belief that low fidelity is better for beginners and high fidelity is for expert learners. Medical students are regarded as novice learners and have little or no working experience. These conventional beliefs lead to the conclusion that it is unreasonable and not cost-effective to expose medical students to high physical fidelity simulation training. However, this overlooks the importance of functional or psychological fidelity. In recent years, studies have suggested that functional or psychological fidelity is important in enhancing learning.[7,12-15] In addition to simulating real-world functioning, high psychological fidelity also creates a stressful environment, increasing student arousal level and facilitating learning and performance. Therefore, in our training course, in addition to the relatively high physical fidelity provided by the well-equipped simulation training room and sophisticated manikin, we further enhanced functional or psychological fidelity by the following interventions:

- A short briefing session before the scenario emphasised behavioural authenticity (such as doing real chest compression and discharging full energy for defibrillation) and psychological immersion. This is equivalent to a fiction contract to suspend disbelief described in clinical simulation training literature.[15,16]
- All participants and the instructor wore clinical attire, including white coats and nurse uniforms that simulated real staffing in an emergency department.
- The instructor behaved as a helpful nurse and talked in a submissive manner while occasionally offered hints with limited scientific knowledge out of past experiences.
- The instructor might immediately remind or even criticise participants who demonstrated non-immersive clinical behaviour such as laughing, suboptimal chest compression, or non-participative gesture.
- Stress level was enhanced by the absence of real-time coaching in critical clinical conditions. Students were made to solve challenges and overcome difficulties or uncertainty by themselves with a deteriorating patient in front of them.

All of these measures enhanced functional fidelity by providing a realistic working environment and imposed psychological immersion for the participants.

A further remark on the term "fidelity" is that physical and psychological fidelity are not mutually exclusive nor competitive, but are actually complementary to each other.[17-20] For example, a high-fidelity manikin who can talk or moan can enhance psychological stimuli for the participants.

Some of the learning outcomes of the course are closely related to psychological fidelity, namely teamwork, working under stress, identifying one's own weakness, acute patient management, and situation awareness. In the written responses under these headings, we could see interaction, flow of information, stress, and self-reflection.

Gaps in undergraduate medical education

Although not the original objective of this study, we found that the unexpected learning outcomes of this study echoed some of the identified gaps between transitions from undergraduate medical education to early postgraduate medical practice in the literature. In the medical education literature there have been calls worldwide for reform of undergraduate medical curricula, to address gaps identified in undergraduate medical education that adversely affect medical interns in their early practice.[21-25] These gaps include working under stress, working on call, uncertainties, helplessness, workload, difficulties prescribing medication, and managing acutely ill patients, and similar gaps have been identified in medical educations programmes across the world.

Newly graduated interns perceive their work to be stressful and have feelings of being underprepared.[23-25] Educators have suggested that undergraduate curricula should prepare medical students to deal with expected stress, such as facing uncertainty, knowing one's limitations, and asserting one's right for support.[21,26,27] These wordings or identified gaps were found in the perceived learning outcomes of our course. In the literature, interns have indicated that they could not predict their shortcomings in their undergraduate study until they were in clinical practice. Furthermore, it was also suggested that undergraduate medical education should include more on communication skills and emotional involvement.[21,28,29] Again these aspects match the perceived learning outcomes of our course.

More work-related training should be put in the final year of medical school, particularly for dealing with acutely ill patients and prescribing medication.[30-32] Studies have shown that despite curriculum reform, management of acute problems has remained an unclosed gap.[30,33,34] Work-related training with acutely ill patients is difficult to achieve because such patients are not always readily available even if medical students do a period of assistant internship. This is a likely reason that curriculum reform and workplace placements during their final year closed some gaps but not others.[20,21] The opportunities for students to experience real acute care are limited, making it difficult to build expertise through repetitive practice.[35,36] Furthermore, there is always an ethical consideration of whether to allow students to treat acutely ill patients.[37]

The learning outcomes of our study suggest that high-fidelity simulation training can be a solution to the gaps identified. High-fidelity simulation training can create a lot of scenarios with acutely ill patients in a short period of time, to create an environment in which students can make mistakes and learn from these mistakes without harming real patients. This idea is supported by the literature, which demonstrates simulation training is better than other forms of instruction method such as didactic or problem-based learning and should serve as an adjunct to other instruction methods.[2,38,39] This point is particularly important because interns or junior doctors are the first medical responders called to attend acutely deteriorating patient in a ward and their suboptimal management might put patients at risk or delay appropriate treatment.[21,29] The General Medical Council of the United Kingdom also recommends the use of simulation technology in medical school.[22]

The limitations of this study include that data were collected from only one medical school, the current curriculum was not discussed, the cohort included students at different times in their final year, and most (but not all) students were recruited before formal clinical placement.

Summary

There are gaps between undergraduate medical education and transition to postgraduate clinical practice which could be eliminated through reform of undergraduate medical school curricula. The application of psychologically immersive high-fidelity simulation training for medical students is likely to be a helpful strategy to enhance their preparedness. Such training should emphasise management of acutely ill patients.

Author contributions

All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity. YF Choi wrote the article. All authors contributed to the concept of study, acquisition and analysis of data, and critical revision for important intellectual content.

Conflicts of interest

As an editor of the journal, TW Wong was not involved in the peer review process. The other author has disclosed no conflicts of interest.

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Ethics approval

No real patients were involved in this study and no personal data was collected from the participants. Verbal consent was obtained from all participants in the introduction session of the course; participation was non-compulsory. The study was approved by the hospital ethics committee (Ref HKECREC-2019-013).

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Answers to CME Programme
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I. Common urological problems in children: primary nocturnal enuresis

A	1. True	2. True	3. True	4. True	5. True
B	1. False	2. True	3. True	4. True	5. True

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II. Clinical considerations when adding a sodium-glucose co-transporter-2 inhibitor to insulin therapy in patients with diabetes mellitus

A	1. False	2. False	3. True	4. True	5. False
B	1. True	2. False	3. True	4. False	5. True