

The Impact of Experiential Learning on NUS Medical Students: Our Experience With Task Trainers and Human-patient Simulation

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Abstract

Introduction: Experiential learning is one of the key methods for effective teaching of medical students. The use of simulation is ideal to achieve this goal. Simulation training allows the learner to be actively involved, and provides realism, self-direction, feedback and practice. We present 2 pilot projects in which the efficacy of experiential learning with simulation is demonstrated. **Materials and Methods:** In the first project, groups of 4 to 6 fourth-year medical students were exposed to common crisis scenarios. Each student took turns to individually handle the situation (in the hot seat), while the rest of the group watched "live" via video-link. A group debrief was done after the completion of all scenarios and learning points were emphasized. A test was conducted shortly after, and the student who managed the same scenario in the hot seat earlier was compared to the rest of the group with respect to crisis recognition, management and diagnosis. In the second project, 36 fourth-year medical students were assigned to learn endotracheal intubation through a directed or experiential method. Students were recalled after 3 months and tested on 4 major categories: preparation, technique, success and ventilation. **Results:** Students in the hot seat tended to perform better (72% vs. 64%), and were more likely to be the highest scoring student within their group; although this did not reach statistical significance. For the intubation study, students in the experiential group had a higher success rate at 3 months (78% vs. 41%). **Conclusions:** Experiential teaching methods with simulation result in better learning of crisis management and endotracheal intubation.

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Key words: Crisis, Experiential learning, Intubation, Simulation

Introduction

The realisation that students have different cognitive and learning styles has had major implications on medical curriculum design efforts. If the student's learning style is mismatched with the teaching style or the teaching environment, the student may spend considerable effort to adapt, and this may negatively impact the student's performance.¹ In the 1970s, Kolb described an experiential learning model which led to the development of the Kolb learning cycle.² This forms the basis of many curriculum models, such as the McCarthy 4MAT system.³

Kaufman describes 7 principles to adopt when applying educational theory to the practice of teaching medical education.⁴ These are that (1) the learner should be an active contributor; (2) learning should closely relate to real life problems; (3) the learners' current knowledge should be taken into account; (4) learners should use self-direction; (5) learners should have opportunities for practice, self

assessment and feedback; (6) learners should be given the opportunity to self-reflect, and (7) the use of role models. The majority of these principles can be met by the use of simulation in medical education.

The use of simulation allows us to put these educational principles into practice in a safe and repeatable manner. The Department of Anaesthesia, National University of Singapore (NUS) has used both high-fidelity and low-fidelity simulators to teach our medical students. In this paper, we describe our experiences in teaching our local medical students, highlighting in particular the two abstracts that were presented at the recent 3rd Asia-Pacific Medical Education Conference held in Singapore in February 2006.

Materials and Methods

Exemption from Institutional Review Board review was received from the National University of Singapore Institutional Review Board.

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Abstract 1: Learning with the Human-patient Simulator: is it Necessary to be in the “Hot Seat”? A Pilot Study

Background

The Human-patient Simulator (HPS) (Meti HPS-010, Sarasota FL, USA) confers the benefits of hands-on learning in addition to visual learning and active reinforcement inherent in small-group teaching. For these benefits, putting each student into the “hot seat”, i.e., to manage a scenario, has become the norm in HPS teaching. However, a recent study by Morgan et al⁵ questioned the merit of this exercise, as they found no advantage in using the HPS compared to tutor-facilitated video reviews for the teaching of medical students. In Morgan’s study, students had hands-on for only a portion of each scenario, and were observers for the rest of the scenario, deriving no additional benefit compared to the video group. We hypothesize that students gain the full benefits of effective learning only when they are in the hot seat. Therefore, we carried out a pilot study to investigate if students need to be in the hot seat in order to fully benefit from HPS-based teaching.

Method

Fourth-year medical students posted to anaesthesia were recruited and randomly divided into groups of 4 to 6 students. The students were orientated to the manikin, monitors, drugs and all other equipment necessary for successful completion of the scenarios. Each student was assigned a different scenario to manage, while the rest of the group watched via video-link. The scenarios were anaphylaxis, myocardial infarction, pulmonary embolism, tension pneumothorax, hypovolaemic shock and severe bronchospasm. Five learning objectives were emphasised, namely (1) crisis recognition; (2) basic management; (3) differential diagnosis; (4) specific management, and (5) correct drugs. A group debriefing was done at the end of all the scenarios. A tutor facilitated the debrief using videotaped recordings of the scenarios which were paused at appropriate junctures to emphasise learning points, facilitate discussion and field questions. After a break, one of the scenarios that was earlier taught was randomly chosen as the test scenario. Each student was given 10 minutes to manage the scenario. The student who had earlier managed the test scenario during the teaching session was considered to be in the hot seat, with the others as controls. Marking was performed off-line by 2 blinded assessors, using mean scores as the final score.

Results

Fifty-four students participated in this study in 10 different groups; thus, there were 10 hot seat students and 44 control students. The hot seat students had better scores ($72\% \pm 20\%$ vs $64\% \pm 17\%$; $P = 0.257$) (Fig. 1). When scores were

ranked within the groups, hot seat students had the highest score 40% of the time, and were ranked within the top 2 70% of the time (Fig. 2). In contrast, control students ranked within the top 2 only 36% of the time ($P = 0.078$). Hot seat students generally did better in crisis recognition and providing differential diagnosis. Inter-rater agreement was good (correlation = 0.824).

Conclusion

This study suggests that students in the hot seat learn better in crisis recognition and management than those observing, although the sample size was too small to be statistically significant. A bigger study is required to confirm these findings.

Abstract 2: Do Medical Students Learn and Retain the Skill of Endotracheal Intubation Better with Directed or Experiential Learning?

Background

Endotracheal intubation is an important clinical skill. It is, however, a difficult skill to learn and retain. We hypothesize that students will learn and remember how to perform endotracheal intubation better when they are made to experience the difficulties of self-directed (experiential) learning compared to when they are guided from the start (the existing learning method). This study aims to compare the effectiveness of these 2 learning methods in teaching medical students how to perform and retain the skill of endotracheal intubation.

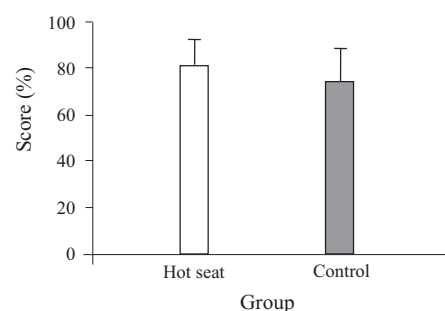


Fig. 1. Hot seat vs control students: comparison of the mean scores.

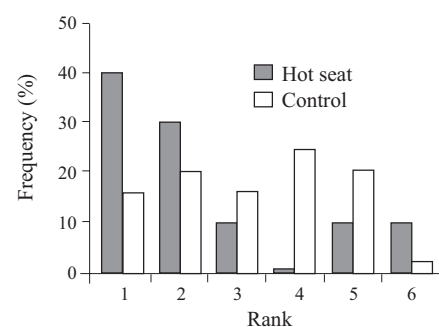


Fig. 2. Hot seat vs control students: frequency of ranks.

Materials and Methods

All fourth-year medical students posted to anaesthesia were recruited and randomly assigned to 1 of 2 learning groups, the directed learning or experiential learning group. All students were initially taught a standard method of endotracheal intubation using a video recording. Students in the directed learning group were then individually brought through intubation by an experienced anaesthesiologist using the traditional step-by-step instruction technique on a half-body manikin (Laerdal ALS Simulator, Wappingers Falls NY, USA). Students in the experiential learning group were left on their own to “sink or swim”; here, the anaesthesiologist took a back seat and allowed the student to figure out the correct technique of intubation, and students were rescued after 10 minutes of trying. Both groups had multiple opportunities to intubate the manikin. The students were recalled 3 months later, and each student was individually tested on their intubation skill using the same half-body manikin. Students were given a pass or fail mark based on their ability to intubate the manikin and confirm correct placement of the endotracheal tube. In addition, students were assessed on 4 major categories for their overall score, namely (1) preparation of equipment; (2) correct intubation technique; (3) successful intubation and confirmation of placement and (4) continued ventilation between attempts. Their attempts were videotaped and analysed off-line by 2 blinded investigators.

Results

Thirty-six students participated in the study, with 17 in the directed learning group and 19 in the experiential learning group. Seventy-eight per cent of the students in the experiential learning group successfully intubated the manikin, compared to 41% of those in the directed learning group ($P = 0.039$) (Fig. 3). The experiential group also had higher overall scores ($82\% \pm 10\%$ vs $72\% \pm 14\%$; $P = 0.038$). The major difference between the groups was that the students in the experiential group were more likely to successfully intubate and correctly confirm placement of the tube ($P = 0.039$). The inter-rater correlation was good (0.853).

Conclusion

Students were able to learn and retain the skill of endotracheal intubation significantly better with the experiential method of learning. This study suggests that adult or experiential learning should be adopted for the teaching of critical clinical skills such as endotracheal intubation.

Discussion

These 2 pilot studies demonstrate the effectiveness of experiential learning. We achieve this with the use of

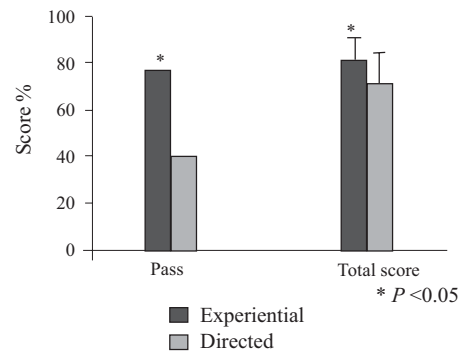


Fig. 3. Endotracheal intubation: comparison of pass rate and total score between experiential and directed groups.

simulators, both low-fidelity with task trainers and high-fidelity with the HPS. Although we could not achieve statistical significance with the first project, there was a strong trend towards better outcome with experiential learning.

The drive towards using high-fidelity simulators such as the HPS is very strong worldwide. This is due, in part, to the fact that medical education is dramatically shifting from a process and structure-based curriculum to an outcome or competency-based curriculum, motivated by increasing demand for public accountability of physician management. In 1999, the Institute of Medicine in the United States published a book titled *To Err Is Human: Building a Safer Health System* in which it was estimated that medical errors caused 98,000 deaths annually (in the United States).⁶ The aims of the book were to create awareness, improve patient safety and recommend strategies to build a better healthcare system. The use of simulation for training was one of the measures advocated in that publication.

In many medical systems, today’s medical students are usually excluded from the management of acutely ill patients.^{5,7} As a result, our young doctors only get to experience first-hand the anxiety of being responsible for very sick patients when they become house-officers. It has been noted that at this point, the risk and cost of adverse outcomes due to medical error may be unnecessarily high.⁸ The use of simulators allow experiential learning, including constructive feedback, repeated learning experience and reinforcement. These learning processes are crucial to the development of expertise in medical practice. In addition, there is no adverse outcome to the patient during this learning process.

Medical educationists worldwide have embraced medical simulation teaching because it promises to enhance learning by targeting commonly elusive pedagogic objectives, including realistic training prior to the care of actual patients, uniform exposure to clinical case material and

responsive, flexible learning in a dynamic environment. Student evaluation of simulation training has also been positive. Many studies, including our own,⁹ have shown that students value simulation-based teaching very highly. In particular, they value the opportunity to manage a realistic medical emergency on their own and in a safe environment. They can practice their theoretical knowledge of resuscitation and develop a more systematic response to an emergency without causing patient harm. They also learn important teamwork skills and feel that their level of competency improves with simulation training.

In the realm of low-fidelity simulation, task trainers have distinct advantages including lower training costs and less trainer time. Task trainers are extremely useful in teaching clinical skills such as suturing, intravenous cannulation and airway manipulation. The major drawbacks with the use of task trainers are the lack of realism and the loss of time-sensitive context. For example, when students are intubating a manikin head, they concentrate on the process, and not on the time they are taking to do it. This contrasts with high-fidelity simulators such as the HPS, which will desaturate fairly rapidly if no ventilation is provided. Nevertheless, the findings of the pilot intubation study highlight that a method that requires independent thinking and application will result in better learning and retention of that skill, as compared to the traditional directed method.

Mastery of clinical skills, such as endotracheal intubation, is important to all practising clinicians in all disciplines of medicine, and may be life-saving for our patients. Unfortunately, endotracheal intubation is a notoriously difficult skill to teach and retain. It is estimated that in order to achieve a 90% success rate, a mean of 47 attempts is required.¹⁰ Furthermore, the ability to successfully intubate is lost quickly over time; a recent study on medical students in the United States reveals that only 62.9% of students retain the skill of endotracheal intubation after 6 months,¹¹ despite undergoing a longer programme than that taught in NUS. In our study, students who were taught using the experiential method had a retention rate of 78% at 3 months. The earlier time to reassessment in our students may have contributed to the difference in success rates, reinforcing the view that retention of this skill quickly declines over time. This makes it even more important to use a learning technique that results in a higher initial success rate.

There are several limitations to this study. First, the students were assessed on their ability to intubate and manage a crisis on manikins. Although the use of simulation improved their performance, there is no direct evidence that this would necessarily result in improved patient outcomes. However, it has been argued that the value of simulation methods for medical teaching should be

considered self-evident, similar to flight simulation in which proof of efficacy has never been established.¹² Furthermore, the amount of “deliberate practice” that simulation allows has been identified as the factor separating the elite performer from others.^{7,13}

Second, it is unknown how big a role, if any, that stress played in our results. We assume that the experiential learning method of the intubation study would be more stressful for the students. This should have impaired the performance of these students as stress is known to impair task performance and working memory.^{14,15} However, stress is also increased by feelings of inadequate mastery of the subject or anticipation of a difficult question.¹⁶ Therefore, it is possible that students in the experiential group may have had decreased stress during their test. This is because the similarity of the test to their learning experience may have given them a greater sense of confidence or knowledge, making stress a potential confounding factor in our results.

Third, we have not identified the ideal group size for HPS teaching. While this study suggests that students learn best when they are in the hot seat, the study did not test for 2 other important components of crisis management, namely team work and resource management. From Morgan’s study, we do know that groups of 6 students are too large.⁵ However, we do not know if groups of 2 to 4 students would be as effective as or even more effective than a student in the hot seat alone as the stress levels would presumably be lessened. We will be embarking on a new study soon to determine the ideal group size and to investigate the role of stress on learning.

The role of simulators in medical education is expanding. Today in NUS, we use simulators in many applications in teaching and training. These applications range from teaching basic physiology and pharmacology to general principles of anaesthesia, as well as crisis management. Clinical and surgical skills can be honed on the simulator even before encountering the patient. Simulators are used to fill gaps in specialty training by allowing repeated practice of managing uncommon medical problems that require timely expert intervention for a successful outcome. Simulators have also been used in the area of learning outcome assessment and evaluation. Our results reassure us that we are on the right track to achieving all these teaching and training aims. We continue to expand our teaching with simulators.

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