Additional simulation training

Cecilio-Fernandes, Dario; Soares Brandao, Carolina Felipe; Catanio de Oliveira, Davi Lopes; Fernandes, Gloria Celeste V. Rosario; Tio, Rene A.

Published in:
BMJ Simulation and Technology Enhanced Learning

DOI:
10.1136/bmjstel-2018-000312

Additional simulation training: does it affect students' knowledge acquisition and retention?

Dario Cecilio-Fernandes,[1] Carolina Felipe Soares Brandão,[2] Davi Lopes Catanio de Oliveira,[3] Glória Celeste V Rosário Fernandes,[4] René A Tio[5]

[1]Center for Education Development and Research in Health Professions (CEDAR), research group LEARN, University of Groningen and University Medical Center Groningen, Groningen, Groningen, The Netherlands
[2]Emergency Department, Universidade Cidade de São Paulo (UNICID), São Paulo, Brazil
[3]Vidas Hospital and Franco da Rocha State Hospital, São Paulo, Brazil
[4]Universidade Cidade de São Paulo (UNICID), São Paulo, São Paulo, Brazil
[5]Department of Cardiology, Catharina Hospital, and Department of Educational Development and Research, and Faculty of Health, Medicine and Life Sciences, Maastricht University, Eindhoven, North Brabant, The Netherlands

Correspondence to
Dario Cecilio-Fernandes, Center for Education Development and Research in Health Professions, Groningen 9713 AV, The Netherlands; d.cecilio.fernandes@umcg.nl

Accepted 30 May 2018
Published Online First 22 June 2018

To cite: Cecilio-Fernandes D, Brandão CFS, de Oliveira DLC, *et al. BMJ Stel* 2019;**5**:140–143.

ABSTRACT

Introduction Teaching medical skills during clinical rotation is a complex challenge, which often does not allow students to practise their skills. Nowadays, the use of simulation training has increased to teach skills to medical students. However, transferring the learnt skills from one setting to the other is challenging. In this study, we investigated whether adding a simulation training before the clinical rotation would improve students' acquisition and retention of knowledge.

Methods Two subsequent cohorts were compared. Group A followed the traditional curriculum without additional simulation training. Group B attended an additional simulation training, in which history taking, physical examination and procedures for the primary survey in emergency situations were taught. Both groups answered the same knowledge test before entering their clinical rotation and after 6 months. To analyse students' scores over time, we conducted a repeated measure analysis of variance. To investigate the difference between knowledge, we conducted a t-test.

Results Group B scored significantly higher in both tests and all subscores, except in the Trauma topic in the first measurement point. Students in group A showed decay in knowledge whereas group B showed an increase in knowledge.

Conclusions Adding a simulation training, before students entered their clinical rotation, improves students' knowledge acquisition and retention compared with those who did not receive the additional simulation training.

INTRODUCTION

The teaching of procedures to be used in severely ill patients is a very complex challenge, which obviously involves restrictions. The main restriction is that the teacher-physician during the procedure needs to focus almost all his attention on the patient. Despite the importance of experiencing this situation for the students' learning process, students often face difficulty in learning the correct procedure or cannot follow the supervisors' line of reasoning.[1]

In the Brazilian context where medical students face severely ill patients soon after starting clinical rotations, most of the students have to deal with severe traumas, such as car accidents and gunshots, during their clinical rotation or when they are on call.[2] Medical students have a crucial role in those encounters. They are responsible for helping the medical doctor, for example, during resuscitation, and by getting and preparing the medication and the necessary material. Although medical students may possess the necessary knowledge, they have limited opportunity to train the necessary skills before starting their clinical rotation. Also, a review showed that medical school training in the care of acutely ill patients may be suboptimal and may place patients at risk.[3]

Inserting simulation training before medical students start their clinical rotation may better prepare them to face those cases, increasing their knowledge, skills and competence. This type of training is often called just-in-time learning, which refers to acquiring knowledge and skills just before students will actually use it.[4] The simulation training allows students to learn from their mistakes in a controlled environment contributing to their learning process.[5–7] Differently from a real-life situation, there is no real harm to the patient and students can actively perceive what happens in the situation and how to act.[5–7] Despite these considerations, it is important to emphasise that these active learning strategies are not intended to replace students' learning in the real-life situation but, in fact, to prepare them most appropriately and completely possible, minimising the occurrence of errors.[7]

Simulation has been successfully used as a teaching strategy in a wide range of professional training activities within healthcare education.[5 8] In this circumstance, it is possible to replicate routines of medical professionals, simulating the real conditions of stress to which these professionals will be submitted in their professional life.[8 9] Issenberg *et al*[5] emphasise that "simulation brings benefits that include improvements in certain technical skills, surgical skills, cardiovascular examination skills and acquisition and maintenance of knowledge, in comparison to traditional lectures and classes". The literature also shows that students who have early contact with simulation can acquire a solid foundation of fundamental skills in semiotics technique and communication since it is a more realistic and meaningful way of learning.[10–12]

Learning a skill involves students to automatise the required actions, which requires practice. In the beginning, students have to constantly remember the correct instruction, which slows down the performance and may lead to errors since it is cognitively demanding.[13] With practice, students will automatise their skill, decreasing the amount of errors.[14] The skill becomes automatised when declarative knowledge is transformed into procedural knowledge, known as proceduralisation.[14 15]

At first, students' procedural knowledge is general and as they practice this knowledge becomes highly specified.[13]

It has been shown that knowledge retention by using simulation is important for clinical practice because the knowledge acquired through this method is kept for a longer time compared with other strategies.[16] Also, it brings greater levels of satisfaction to students and instructors.[16] It is unclear, however, what is the optimal amount of simulation training since no studies have investigated that.[17] It is also unclear whether a simulation training would support students' skill and knowledge acquisition by creating general procedural knowledge, and, later on, with practice, support students' acquisition and retention of specific knowledge. Technical skills, which are generally considered motor or psychomotor skills medical doctors need to perform, are often taught without context since the training of technical skills focus on the motor or psychomotor part of the skills. Adding context may support students' acquisition and retention of specific knowledge. Thus, this study investigates whether inserting a simulation training, which adds the context to the technical skills, before students entered their clinical rotation increases students' acquisition and retention in specific knowledge. We expected that immersing students in this simulation training would decrease students' cognitive load, thus, increasing students' retention of specific knowledge.

METHODS

Context

The Universidade Cidade São Paulo (UNICID) has a 6-year undergraduate course in which the first 4 years are the preclinical training and the last 2 years are the clinical training. During the preclinical training, students practise their technical skills in low-fidelity simulation training. The training of technical skills increases in complexity as students progress through the curriculum, varying from very simple (eg, taking the blood pressure) to very complex (lumbar puncture) technical skill. During the clinical training, students spent most of their time in the hospital, with 3 hours per week dedicated to high-fidelity simulation training. Students have to attend these weekly simulation training sessions about emergency medical situations, including scenarios related to trauma, cardiology and paediatrics. After each training, there is a debriefing session in which the instructor guides the discussion regarding the scenario. The cohorts were divided into small groups (maximum of 10 students) to attend the training sessions, and all groups received the same training and scenarios.

Study design

In this study, we compared two subsequent cohorts, which followed the medical curriculum at UNICID, Brazil and entered their clinical rotations either in January 2016 (group A) or August 2016 (group B). Group B was the first cohort after implementation of a simulation training, before students entered their clinical rotation. During this simulation training, students were taught skills needed for emergency situations such as history taking, physical examination and procedures necessary for the primary survey of a patient. In addition, students got familiarised with an emergency room and the available material inside it. Moreover, students were taught how to use the material and practised their technical skills like orotracheal intubation and intraosseous puncture using a high-fidelity scenario, which was different in each session. Each scenario was designed with a topic and the necessary skills. For example, if the topic were meningitis, the necessary skills would be a physical examination, lumbar puncture, interpretation of the results and making a treatment plan. Those simulation trainings were designed to add the context of complex scenarios before entering the clinical rotation by linking the clinical case with the technical skills. It was also designed to support student learning by giving feedback during the simulation training. If a mistake were made, the instructor would stop the training and give feedback to the students. Furthermore, this training focused on the reasoning and allowed students to practise their technical skills. This simulation training was included in time allocated for students' self-study time. Students had to attend a weekly simulation training of 1 hour for 17 weeks. During this 1-hour session, students had a hands-on training by attending a clinical case. Students have to study the learning material before the simulation training. Including a simulation training before the clinical rotation gave us the opportunity to compare two cohorts: one without (group A) and one with (group B) the additional simulation training.

Both groups took a knowledge test twice: at the end of the fourth year and after 6 months. The knowledge test consisted of 30 multiple-choice questions regarding cardiovascular (Cardio) emergencies, polytraumatised patients (Trauma) and obstetric emergencies (OB). Most of the questions required students to apply their knowledge (n=17), and the other questions (n=13) required students to only reproduce their knowledge. During the simulation training, although there was a formative assessment used to guide the debriefing session, no grades were given to the students.

Ethical aspects

This study was approved by the ethical committee of the UNICID. The two cohorts of students were invited to participate in the study: participants were asked to answer two knowledge tests, one before and 6 months after entering their clinical rotation. Students were informed about the goal of the study, that there were no implications for the grade and that their participation was voluntary. After reading the informed consent, students signed the informed consent form. Only students that signed the informed consent took both knowledge tests.

Data analysis

We computed the overall scores as well as the scores for each part of the knowledge test, Trauma, GO and Cardio. To analyse students' scores over time, we conducted a repeated measure analysis of variance (ANOVA) to calculate for each test subscores and total score.

To compare the scores between the two groups for each test, we used independent t-test.

RESULTS

A total of 101 students participated in the study. Of those, 55 students were in group A and 46 in group B.

Overall, group B scored higher than group A. All the differences found were significant, with the exception of the subject Trauma in Test 1 (table 1).

For the total score, group B scored higher than group A in the first knowledge test. In the retention test, group B increased whereas group A decreased (table 1). The repeated measures ANOVA showed a main effect between groups ($F(1,45)=178.187$, $p<0.001$), but not between time ($F(1,45)=3.634$, $p>0.05$). Further, an interaction effect between time and group was found ($F(1,45)=17.304$, $p<0.001$).

For the Trauma score, group B scored higher than group A in the first knowledge test. In the retention test, group B increased

Table 1 Mean, independent-samples t-test between the groups and significance values of the variable knowledge test for Cardio, Trauma, OB and Total in Tests 1 and 2

Discipline	Group	N	Mean test 1	T	Mean test 2	T
Cardio	A	55	6.0	−7.504*	5.1	−9.774*
	B	46	8.6		8.5	
Trauma	A	55	7.4	−1.285	6.6	−7.446*
	B	46	7.8		8.8	
OB	A	55	5.4	−5.200*	4.9	−7.224*
	B	46	7.0		7.0	
Total	A	55	18.8	−6.352*	16.7	−11.357*
	B	46	23.4		24.3	

*$p<0.05$.

whereas group A decreased (table 1). The repeated measures ANOVA showed a main effect between groups ($F(1,45)=37.527$, $p<0.001$), but not between time ($F(1,45)=0.82$, $p>0.05$). Further, an interaction effect between time and group was found ($F(1,45)=18.553$, $p<0.001$).

For the Cardio score, group B scored higher than group A in the first knowledge test. In the retention test, both groups had a decrease in their scores (table 1). The repeated measures ANOVA showed a main effect between time ($F(1,45)=5.396$, $p<0.05$) and groups ($F(1,45)=141.136$, $p<0.001$). Further, an interaction effect between time and group was found ($F(1,45)=4.429$, $p<0.05$).

For the OB score, group B scored higher than group A in the first knowledge test. In the retention test, group B scored similarly to the first test. Group A showed a decrease in their scores (table 1). The repeated measures ANOVA showed a main effect between groups ($F(1,45)=73.371$, $p<0.001$), but not between time ($F(1,45)=2.5$, $p>0.05$). Further, an interaction effect between time and group was not found ($F(1,45)=3.275$, $p>0.05$).

DISCUSSION

In this study, we investigated the effect of implementing a simulation skills training before students entered the clinical phase on students' knowledge acquisition and retention. Our results demonstrate that students who received this additional simulation training acquired and retained more specific knowledge than those who only received the traditional simulation training.

Both the additional simulation and the technical skills training mainly focus on students' skills, but not on the acquisition of knowledge. However, our findings indicate that the additional simulation training supported students' acquisition of knowledge and more importantly, students acquired and retained more knowledge throughout their clinical rotation, differently from those who only attended the technical skills training. This difference is clearly observed in the subscore for trauma. Obviously, the effect of the additional simulation training for trauma was most pronounced. It is unclear why, but this may have been influenced by the fact that exposure to trauma cases during their rotation is more frequent than in cardiology or obstetrics. Unfortunately, we do not have data on which and how many cases students encountered during their rotations. However, it seems that students who received the additional simulation training learnt more than those who only took the technical skills training. In countries where medical students and recently graduated medical doctors are responsible for the primary survey, the inclusion of a simulation training earlier in the undergraduate medical training may benefit students' knowledge acquisition and retention of specific content.

Although the primary survey is a great learning experience for medical students, it also demands that students possess a certain level of knowledge and skills. It seems, however, that medical students at this stage benefit more from a simulation training that adds the context and gives immediate feedback than actually learning the technical skills. One explanation might be that the design of the additional training decreased students' cognitive load during the training of technical skill. Also, adding context has been shown to improve learning.[13] Understanding the context of the technical skills may also support students to transfer the same technical skill to another context. Therefore, they can be applied to all primary surveys, whereas training only technical skills may focus too much on a case that students cannot transfer to other cases. Another explanation might be that the additional training allows students to structure their primary survey and line of reasoning better, allowing students to develop a systematic response to the primary survey.[7] Finally, it may be a matter of cognitive load. Students who already master the technical skills can put more effort in learning discipline-specific skills and knowledge.[18]

Due to the naturalistic setting of this study, many variables uncontrolled for could have affected our study. For example, it was not possible to control for the number of cases students have encountered or treated. However, the naturalistic environment offers a closer look at real-life situations, whereas experimental design has been criticised for the lack of reproducibility in naturalistic settings, especially in medical education.[19] Another limitation might be that one group received more hours of simulation training than the other. However, the number of hours at the university are the same for both groups; thus, students had the same number of hours but divided differently. Further studies should investigate the impact of the additional skills training on medical students' performance in the emergency room. Finally, further research should investigate whether the additional skills training increases students' knowledge in other clinical rotations as well.

CONCLUSION

Our results reveal that adding a simulation training that adds context and gives immediate feedback improves students' acquisition and retention of knowledge during a clinical rotation. Possibly, the additional training reduced students' cognitive load during the acquisition of the more specialised knowledge.

Contributors CFSB, DLCdO and GCVRFF conceived the original idea of the study. All authors contributed substantially to the conception and design of the study. DLCdO gathered the data. DC-F and CFSB analysed the data and wrote the first draft of the manuscript under the supervision of RAT. All authors contributed to the interpretation of the data and revised it critically in terms of significant intellectual content. All authors approved the final manuscript for submission.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Ethics approval This study was approved by the ethical committee of the UNICID.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1 Grantcharov TP, Reznick RK. Teaching procedural skills. *BMJ* 2008;336:1129–31.
2 Purim KSM, Borges LMC, Possebom AC. Perfil do médico recém-formado no sul do Brasil e sua inserção profissional. [Profile of the newly graduated physicians in southern Brazil and their professional insertion]. *Rev Col Bras Cir* 2016;43:295–300.

3 Smith CM, Perkins GD, Bullock I, *et al*. Undergraduate training in the care of the acutely ill patient: a literature review. *Intensive Care Med* 2007;33:901–7.
4 Barnes BE. Creating the practice-learning environment: using information technology to support a new model of continuing medical education. *Acad Med* 1998;73:278–81.
5 Issenberg SB, McGaghie WC, Hart IR, *et al*. Simulation technology for health care professional skills training and assessment. *JAMA* 1999;282:861–6.
6 Motola I, Devine LA, Chung HS, *et al*. Simulation in healthcare education: a best evidence practical guide. AMEE Guide No. 82. *Med Teach* 2013;35:e1511–e1530.
7 Weller JM. Simulation in undergraduate medical education: bridging the gap between theory and practice. *Med Educ* 2004;38:32–8.
8 Rauen CA. Simulation as a teaching strategy for nursing education and orientation in cardiac surgery. *Crit Care Nurse* 2004;24:46–51.
9 Daglius Dias R, Scalabrini Neto A. Stress levels during emergency care: a comparison between reality and simulated scenarios. *J Crit Care* 2016;33:8–13.
10 Spunt D, Shpritz D. *Clinical laboratory course development and management. Online health science education: development and implementation*. Philadelphia: Lippincott, Williams and Wilkins, 2006:154–65.
11 Scherer YK, Bruce SA, Graves BT, *et al*. Acute care nurse practitioner education: enhancing performance through the use of clinical simulation. *AACN Clin Issues* 2003;14:331–41.
12 Fuszard B. *Innovative teaching strategies in nursing*. New York (NY): Aspen Publishers, 1995.
13 Taatgen NA, Huss D, Dickison D, *et al*. The acquisition of robust and flexible cognitive skills. *J Exp Psychol Gen* 2008;137:548–65.
14 Anderson JR. Acquisition of cognitive skill. *Psychol Rev* 1982;89:369–406.
15 Taatgen NA, Lee FJ. Production compilation: a simple mechanism to model complex skill acquisition. *Hum Factors* 2003;45:61–76.
16 Nestel D, Groom J, Eikeland-Husebø S, *et al*. Simulation for learning and teaching procedural skills: the state of the science. *Simul Healthc* 2011;6 Suppl:S10–13.
17 Heitz C, Eyck RT, Smith M, *et al*. Simulation in medical student education: survey of clerkship directors in emergency medicine. *West J Emerg Med* 2011;12:455–60.
18 Sun NZ, Anand PA, Snell L. Optimizing the design of high-fidelity simulation-based training activities using cognitive load theory—lessons learned from a real-life experience. *Journal of Simulation* 2017;11:151–8.
19 Prideaux D. Researching the outcomes of educational interventions: a matter of design. RTCs have important limitations in evaluating educational interventions. *BMJ* 2002;324:126–7.