Simulation based training to improve acute care skills in medical undergraduates

Article *in* The New Zealand medical journal · November 2004

Source: PubMed

Jennifer M Weller
University of Auckland

Brian Robinson
Capital & Coast District Health Board

Peter D Larsen
University of Otago

THE NEW ZEALAND
MEDICAL JOURNAL
Vol 117 No 1204 ISSN 1175 8716

Simulation-based training to improve acute care skills in medical undergraduates

Jennifer Weller, Brian Robinson, Peter Larsen, Catherine Caldwell

Abstract

Aim Acquisition of clinical skills by medical undergraduates can be problematic, especially in the context of medical emergencies. Simulation using computerised manikins may be an effective and ethical solution. We assessed the ability of undergraduates to manage medical emergencies, and evaluated simulation as an educational and assessment tool.

Method Medical undergraduates were assessed in standardised, highly contextualised simulations of medical emergencies using both checklists and global ratings, and were reassessed following a simulation-based educational intervention to measure learning effect. The scores for groups at different levels of training were compared to test construct validity of global ratings of simulator performance. We explored student perspectives of simulation through thematic analysis of questionnaire responses.

Results Seventy-one students were studied. Final year students performed significantly better than fourth year students, but the ability to initiate management of medical emergencies was unsatisfactory in both groups. Performance improved significantly over the course of the simulation workshop. The learning processes in simulation-based education were perceived as more effective than traditional methods, and consistent with known principles of effective learning. Students felt the simulations were a reasonable measure of their abilities and 91% felt that such simulations should be included in their end-of-year assessment.

Conclusion Current medical undergraduate training does not ensure new graduates can intervene effectively in an emergency. Simulation-based workshops are effective and should be incorporated into the undergraduate curriculum both for education and assessment of competence in emergency management.

One of the expected outcomes of medical undergraduate training in New Zealand is the ability to manage a range of clinical emergencies, including the initial management of a shocked patient.

There is considerable evidence that clinical skills may be poorly taught and students may be ill-equipped to deal with the demands of a house surgeon year.[1] Training for medical emergencies during undergraduate years traditionally includes reading, lectures, tutorials, and clinical experience. Only clinical experience is aligned with the desired learning outcome, but is limited by the unpredictable occurrence of emergencies and the ethical problems of allowing medical undergraduates to learn on acutely ill patients.

Patient simulation provides a safe learning environment (where events can be scheduled, repeated, and observed) offering the potential for greater efficiency and rigour over traditional methods. Simulation has in fact been described as an ethical imperative, but has not yet been widely incorporated into the medical undergraduate curriculum[2–4].

Recent studies have provided evidence on the reliability and validity of simulation in assessment of both anaesthesia skills[5,6] and acute care skills.[7] In terms of effectiveness, there is some evidence that anaesthetists' performance improves following training,[8,9] and improved anaesthesia skills in medical undergraduates have been demonstrated following training.[6] There is currently little evidence on the effectiveness of simulation in the context of emergency management in medical undergraduates.

We hypothesised that new medical graduates may not be competent to initiate emergency care in unstable patients and that this deficiency could be addressed through simulation-based education.

Method

Procedure—Ethics committee approval was received from the Wellington Ethics Committee.

Over a 6-month period, 71 medical undergraduates in their 4th and 6th (final) year were scheduled to attend a 3-hour simulation-based workshop.

Ethics approval was obtained, information provided to participants and written consent obtained.

We used the Laerdal SimMan full-body computerised manikin, integrated with monitoring devices, airway, and resuscitation equipment. The manikin is capable of simulating speech and a range of clinical signs including chest movement, breath sounds, heart sounds, and pulses. Airway interventions, fluid, and drug administration, cardioversion, and defibrillation are possible. The model will generate an ECG, blood pressure, pulse oximetry, and capnography trace.

Students underwent an initial period of familiarisation with the simulator and equipment. In the workshop, students worked in teams in one of three scenarios, each team completing the same scenario twice (baseline and repeat). The scenarios focussed on a theme of post-operative shock and were set in a simulated surgical ward. A faculty nurse was present during the scenarios and provided additional cues on 'patient' appearance and could assist with monitoring tasks. Information was available in patient notes and charts when requested.

The first 5-minute period of each scenario was standardised and scripted to allow consistent scoring and comparison between baseline and repeat performances. Scenarios were designed that required immediate action within this 5-minute timeframe. After the initial test period, if required, the faculty nurse could offer suggestions to students to direct them towards appropriate management. This was to ensure that correct treatment was eventually given, the 'patient' survived, and the simulation experience was positive for the students.

The baseline scenario (5–7 minutes duration) tested entry level skills. Workshop training consisted of participation in simulations, observation of peers, feedback following simulations and a facilitated discussion during which students developed a systematic approach to the shocked patient. The repeat scenarios were of 10–15 minutes duration, with the initial 5 minutes identical to the baseline.

Students gave written statements in response to a questionnaire seeking their views on learning processes in simulation and use of simulation in their assessment.

The videos of the baseline and repeat simulations were randomised then assessed independently by two expert examiners not involved with the workshop; these examiners scored the 5-minute test period of the scenario. One examiner was a specialist anaesthetist and experienced simulation centre instructor, and the second examiner was a senior New Zealand Resuscitation Council instructor.

The examiners were blind to the year level of the student team and the order of the scenarios. One instructor had no prior knowledge of the students. An anchored five-point rating scale was used to score three dimensions of performance: systematic approach to the problem, clear leadership and division of tasks between team members. The scores for the three dimensions of performance were averaged, and the mean of the two examiners' scores taken to give a global score for performance in each baseline and repeat scenario. In addition, a checklist score was generated from a list of key clinical management tasks.

Statistical analyses—Quantitative data from questionnaires were analysed using descriptive statistics and written responses were coded and grouped into themes.

The Wilcoxon matched-pairs signed-ranks test was used to compare global scores in the baseline and repeat scenarios and to compare 4th year and 6th year scores.

The Mann Whitney U test was used to compare checklist scores of 4th and 6th year students.

Results

All 71 students who attended the workshops agreed to take part in the study (45 fourth-year students, 26 sixth-year students). All students completed the questionnaire. A total of 21 pairs of baseline and repeat scenarios were scored by the two examiners (Table 1).

Table 1. Scores for 4th- and 6th-year students for the three baseline and repeat scenarios

Scenario		Year of training	n	Median*
Scenario 1	Baseline	4th	5	1.5
		6th	4	2.58
	Repeat	4th	5	2.83
		6th	4	3.58
Scenario 2	Baseline	4th	3	2.0
		6th	3	2.5
	Repeat	4th	3	2.33
		6th	3	3.00
Scenario 3	Baseline	4th	3	1.83
		6th	3	2.83
	Repeat	4th	3	2.33
		6th	3	3.33

*Median score of all the teams at that year level; n=number of teams rated on a rating scale of 1 to 5 where 1 is poor and 5 is good.

Results of video ratings of performance—On a scale of 1–5, where a score of three equated with adequate performance, the median score in the baseline scenario was 1.83 for the 4th-year students and 2.3 for the 6th-year students. In the repeat scenarios, median scores improved to 2.67 and 3.33 for the 4th- and 6th-year students, respectively.

The median scores for the two groups in each of the three scenarios (Table 1) shows evidence of improvement in each of the three scenarios. Combining all pre-test and all post-test scores, overall there was a significant improvement from baseline to repeat ($p<0.001$). Scores were compared to see if there was a difference between 4th- and 6th-year students. The median scores for 6th-year students were significantly higher than for 4th-year students for both baseline ($p<0.01$) and repeat scenarios ($p<0.001$).

The students performed significantly more ($p<0.05$) key tasks in the repeat scenarios than the baseline scenarios (Table 2).

Table 2. Comparison of average checklist scores for baseline and repeat scenarios (total possible scores 21, 20, 21 for scenarios 1, 2, and 3 respectively)

Scenario	Baseline*	Repeat*	P value
Scenario 1	13 (11–18)	17 (14–19)	0.01
Scenario 2	13 (10–16)	16 (11–17)	0.04
Scenario 3	14 (11–18)	15 (13–19)	0.04

Students compared the process of learning in the simulation workshop with their traditional education in this domain. All 71 students identified advantages, and a number of themes emerged from the written statements (Table 3). Active engagement with the material, and the need to make decisions and to commit to action in a realistic timeframe were seen as effective ways of learning and remembering. Students felt they had to 'make decisions quickly that really matter' and 'look at the findings because you understand the importance'.

Students valued hands-on practice of clinical skills, the use of equipment 'to see how things would be done in practice', and discovered how difficult it was to actually manage a case compared to discussing what should be done, as illustrated by the following student.

> 'Theory's all very well but you gotta (sic) know how to turn on the oxygen before you can administer it'

The transfer of theoretical knowledge to practice was recognised as an essential step, which was facilitated by the simulation workshop:

> 'Even though we may know the theory, it is much different in practice'

For many students, the simulations provided a memorable and realistic experience from which to learn:

> 'It's a wonderful way to learn because you remember the situation and the devised plan of attack'; '[The] experience sticks in your mind because you are using all 5 senses'

Simulation helped students see the relevance of their theoretical knowledge and sort out what was important:

> 'With reading, it is difficult to pick out the key points, here it is obvious'

The simulations identified gaps in students' knowledge and motivated learning, characterised by this student's thoughts:

> 'It motivates me to thoroughly learn the theory as I have realised the seriousness of emergencies / resuscitation and the implications of being ignorant'

Seventy out of the 71 students (99%) agreed that they had identified areas they needed to learn more about, and 67 identified specific areas they intended to address. Eleven students commented on the stressful nature of the experience. They felt 'thrown in at the deep end', and felt under pressure. However, without exception, these same students linked this feeling to a positive learning experience, describing the value of 'hands on experience under pressure'. The stress made the experience more memorable, and in fact, was described as 'a good way to get over it'.

Table 3. Thematic analysis of written responses on the process

Themes on learning processes	N*
Putting knowledge into practice	16
Active engagement with material	14
Practical nature	13
Learning from experience	5
Opportunity to practice for clinical event	4
Demonstrates relevance, motivates learning	4

*N=number of students responding in each theme.

Most students thought that the simulator could provide a fair measure of their ability to manage a critically ill patient and 91% thought it should be included in a hypothetical end of year assessment (Table 4). Sixty-five students gave written responses on the subject of assessment. The realism of the simulation assessment emerged as a prominent theme (n=27). It was "obviously testing what one needs to know," and it tested teamwork and the ability to solve problems under pressure. Students recognised limits to fidelity (n=12), but also commented that simulation was more valid than written tests. They considered prior training in the simulator to be a prerequisite of any assessment (n=13). Assessment in a team was considered as potentially unfair; but on the other hand, the ability to work in a team was important and reduced the stress of the simulation (n=13). (Numbers in brackets are number of responses in that category)

Table 4. Students' opinions of simulation as an assessment tool.

Simulation-based assessment	Yes*	No*	Unsure*
Good measure of ability	55 (80%)	12 (17%)	2 (3%)
Should be included in assessment	63 (91%)	6 (9%)	0

Discussion

In this study, we found that the ability of final year medical students was assessed as less than satisfactory in the domain of emergency care, and that performance was improved following a simulation-based workshop. Students saw simulation as a credible and acceptable assessment tool, and the consistently higher scores achieved by more senior students support construct validity of simulation-based assessment. The learning processes described by students in the simulation workshops were considered more effective than traditional educational methods in this context and were consistent with known principles of effective learning.[10]

Simulation-based education enables the direct application of learning theory to practice. The theory of constructivism sees the teacher as the facilitator who provides students with relevant experiences targeted to their level of understanding. Learning occurs where students engage actively with the task provided, and is consolidated by in-depth examination of the new experience. The theory of reflective practice argues that professional competence cannot be achieved through formal teaching, but requires exposure to the 'messy' problems of real life. Unexpected events or surprises trigger reflection during the event, so called ‘learning in action’, while subsequent thinking back on what happened, or ‘reflection on action’ relates the event to prior experiences and consideration of how this may affect future practice.

Demonstrating outcomes of educational interventions can be problematic. A number of confounding variables influence results, and unlimited access to students for randomised controlled trials is not feasible due to ethical and resource constraints. A study by Morgan et al [6] compared simulation with video-assisted learning and found no difference in learning effect. However, neither method is standard practice, and in fact there may be little difference in resource requirements. A more useful approach would be to compare simulation with currently used methods. In this study, we compared simulation with the status quo. We considered the baseline performance of final year students nearing completion of their training as a measure of the effectiveness of the traditional approach over their 6 years of training.

A previous study explored what it was that students learnt in simulation workshops in the domain of emergency care.[11] Rather than focussing on specific aspects of medical management, they learnt how to be more systematic in their approach to a problem, how to work together in teams, and how to communicate more effectively. We have taken this further to explore the underlying learning processes in simulation-based education. It is interesting that students identified a number of accepted principles of effective learning,[10,12,13] supporting the sound educational basis of simulation.

Simulation can help students identify gaps in their learning, and motivate them to learn more. These are key factors in promoting self-directed, life-long learning. Kaufman[10] proposed a number of principles to guide teaching practice. These include actively engaging the learner, solving real-life problems, providing opportunities for practice, giving feedback, and facilitating reflection on practice through analysing performance and developing new perspectives and opinions. Clearly these are applicable to teaching in many contexts, but the ease with which they can be applied in simulation based education underlies the power of this innovative teaching tool.

Patient simulators may be useful to assess competence of medical students, and previous studies show that reliable scores can be generated. Boulet et al[7] demonstrated reliability and construct validity of simulation-based assessment using highly specified checklists to score acute care skills. Morgan[5] used checklists to score anaesthesia skills in medical undergraduates. Global scores by experts have been shown to be more valid and reliable than checklist scores to assess complex performance, as checklists tend to reward thoroughness rather than competence, and may not allow for alternative approaches to a problem.[14]

For assessing overall performance in these highly contextualised scenarios, we considered global scores more appropriate than checklists. We demonstrated that senior students scored more highly, supporting construct validity of simulation-based assessment.

Morgan and Cleave-Hogg[15] found students had a positive attitude to simulation-based assessment of basic anaesthesia skills. We have demonstrated this is ‘generalisable’ to assessment of emergency management, where 91% of students thought it should be part of their formal assessment.

Limitations—It is possible that scores may improve in repeated scenarios through increased familiarity with the simulator and the environment. We attempted to minimise this effect through a period of familiarisation with the simulator prior to the scenarios. Increased student exposure to simulation, or cross-over designs with different test scenarios (but similar exposure to simulation) could address this problem, but were not feasible within the time constraints of the student curriculum.

For a high stakes assessment, a large number of cases would be required,[16] and the format used in this study could not reliably rank individual student teams. The combined scores, however, provide a meaningful comparison between the two student groups and between baseline and repeat scenarios.

We demonstrated improvement in performance by the end of the workshop. We are unable to say how long this would persist. Students' comments suggest simulation aids retention of new learning. It would be interesting to know if the acquired knowledge was durable, and if refresher courses were of benefit. This could be a productive area for further study.

Author information: Jennifer Weller, Senior Lecturer, Department of Anaesthesiology, Faculty of Medicine and Health Sciences, University of Auckland, Auckland; Brian Robinson, Director National Patient Simulation Centre, Capital and Coast Health, Wellington; Peter Larsen, Department of Surgery and Anaesthesia, Wellington School of Medicine, University of Otago, Wellington; Catherine Caldwell, Specialist Anaesthetist, Department of Anaesthesia, Capital and Coast Health, Wellington

Acknowledgements: The author is grateful for the support and assistance of Gabrielle Davie, Biostatistician, Department of Public Health, Wellington School of Medicine.

Correspondence: Jennifer Weller, Faculty of Medicine and Health Sciences, University of Auckland, PO Box 92019, Auckland. Fax (09) 623 6587; email: j.weller@auckland.ac.nz

References:

1. Tekian A. Have newly graduated physicians mastered essential clinical skills? Med Educ. 2002;36:406–7.
2. Gordon J, Wilkerson W, Shaffer D, Armstrong E. "Practicing" medicine without risk: students' and educators' responses to high-fidelity patient simulation. Acad Med. 2001;76:469–72.
3. Ziv A, Wolpe P, Small S, Glick S. Simulation-based medical education: an ethical imperative. Acad Med. 2003;78:783–8.
4. Morgan P, Cleave-Hogg D. A worldwide survey of the use of simulation in anesthesia. Can J Anesth. 2002;49:659–62.
5. Morgan PJ, Cleave-Hogg DM, Guest CB, Herold J. Validity and reliability of undergraduate performance assessments in an anesthesia simulator. Can J Anesth. 2001;48:225–33.
6. Morgan PJ, Cleave-Hogg D, McIlroy J, Devitt JH. Simulation technology: a comparison of experiential and visual learning for undergraduate medical students. Anesthesiology. 2002;96:10–6.
7. Boulet J, Murray D, Kras J, et al. Reliability and validity of a simulation-based acute care skills Assessment for medical students and residents. Anesthesiology. 2003;99:1270–80.

8. Weller J, Wilson L, Robinson B. Survey of change in practice following simulation-based training in crisis management. Anaesthesia 2003;58:471–3.

9. Chopra V, Gesink BJ, de Jong J, et al. Does training on an anaesthesia simulator lead to improvement in performance? Br J Anaesth. 1994;73:293–7.

10. Kaufman DM. Applying educational theory in practice. BMJ. 2003;326:213–6.

11. Weller JM. Simulation in undergraduate medical education: bridging the gap between theory and practice. Med Educ. 2004;38:32–8.

12. Brookfield SD. Understanding and Facilitating Adult Learning. Milton Keynes: Open University Press; 1986.

13. Lawson K. The Trainer's Handbook. New York: Jossey-Bass, Pfeiffer; 1998.

14. Regehr G, MacRae H, Reznick RK, Szalay D. Comparing the psychometric properties of checklists and global rating scales for assessing performance on an OSCE-format examination. Acad Med. 1998;73:993–7.

15. Morgan PJ, Cleave-Hogg D. A Canadian simulation experience: faculty and student opinions of a performance evaluation study. Br J Anaesth. 2000;85:779–81.

16. Newble D, Swanson D. Psychometric characteristics of the objective structured clinical examination. Medical Education 1988;22:325–34.

