Can simulation replace part of clinical time? Two parallel randomised controlled trials

Kathryn Watson,1 Anthony Wright,2 Norman Morris,3 Joan McMeeken,4 Darren Rivett,5 Felicity Blackstock,6 Anne Jones,7 Terry Haines,8 Vivienne O’Connor,9 Geoffrey Watson,1 Raymond Peterson10 & Gwendolen Jull1

CONTEXT Education in simulated learning environments (SLEs) has grown rapidly across health care professions, yet no substantive randomised controlled trial (RCT) has investigated whether SLEs can, in part, substitute for traditional clinical education.

METHODS Participants were physiotherapy students (RCT 1, n = 192; RCT 2, n = 178) from six Australian universities undertaking clinical education in an ambulatory care setting with patients with musculoskeletal disorders. A simulated learning programme was developed as a replica for clinical education in musculoskeletal practice to replace 1 week of a 4-week clinical education placement. Two SLE models were designed. Model 1 provided 1 week in the SLE, followed by 3 weeks in clinical immersion; Model 2 offered training in the SLE in parallel with clinical immersion during the first 2 weeks of the 4-week placement. Two single-blind, multicentre RCTs (RCT 1, Model 1; RCT 2, Model 2) were conducted using a non-inferiority design to determine if the clinical competencies of students part-educated in SLEs would be any worse than those of students educated fully in traditional clinical immersion. The RCTs were conducted simultaneously, but independently. Within each RCT, students were stratified on academic score and randomised to either the SLE group or the control (‘Traditional’) group, which undertook 4 weeks of traditional clinical immersion. The primary outcome measure was a blinded assessment of student competency conducted over two clinical examinations at week 4 using the Assessment of Physiotherapy Practice (APP) tool.

RESULTS Students’ achievement of clinical competencies was no worse in the SLE groups than in the Traditional groups in either RCT (Margin [Δ] ≥ 0.4 difference on APP score; RCT 1: 95% CI = 0.07 to 0.17; RCT 2: 95% CI = 0.11 to 0.16).

CONCLUSIONS These RCTs provide evidence that clinical education in an SLE can in part (25%) replace clinical time with real patients without compromising students’ attainment of the professional competencies required to practise.
INTRODUCTION

Simulated learning environments (SLEs) were first employed in medical education almost 50 years ago. Their use has grown enormously over subsequent decades. In emergency medicine programmes, for example, the use of SLEs increased from 29% to 85% within programme curricula within 5 years. The popularisation of the SLE reflects its many purported educational benefits, which include student-centred learning, safe skill acquisition, development of communication skills and the provision of predetermined standardised case experiences, as well as its facility to address growing ethical concerns about whether students should ‘practise’ on patients, and issues involving potential litigation and patient safety. The current international shortage of suitable and available student clinical education and specialty training placements in many professions is concomitant with pressures to increase student numbers to meet rising demand for health care provision. Simulation is now being used to replace some of the time spent in traditional clinical learning environments within medicine, nursing and allied health training.

In Australia, in an initiative of the Councils of Australian Governments, Health Workforce Australia is working to implement the use of SLEs as a means of increasing the capacity of the health care system to provide clinical training across the range of health disciplines.

There are concerns about introducing a clinical education method that replaces time in a real clinic without evidence that it maintains educational outcomes. Enthusiasm for the use of simulation seems to far exceed evidence that students can achieve the range of competencies required in a health professional through practice in an SLE. Health education programmes should provide accountable and beneficial results. There is evidence that certain technical skills can be developed well. Likewise, there is evidence that communication skills can be taught using standardised patients (SPs), who may be actors who are trained to simulate a patient’s illness in a standardised way or actual patients who are trained to present their own illnesses in a standardised way. Nevertheless, although achieving isolated competencies is important, real-life practice with patients requires a range of professional competencies. It is unknown at present whether an SLE can be used for education across all key competencies and whether simulation can in part replace traditional clinical education with real patients sufficiently well to assist students to achieve the key professional competencies required for total patient management. Despite the widespread incorporation of the SLE in health professions education programmes, no substantive randomised controlled trial (RCT) has investigated its effectiveness as a partial substitute for traditional clinical education, prompting growing calls for evidence-based research into the use of the SLE.

To address this deficit, two RCTs were conducted to determine the effects on student achievement of clinical competencies of replacing 1 week of a 4-week traditional clinical placement with learning in an SLE. A curriculum using SPs was developed in the context of entry-level physiotherapy student clinical education in the management of patients with musculoskeletal disorders. It is unknown how best to configure a simulated learning experience within clinical immersion. We developed two models to combine an SLE with traditional clinical immersion. Each SLE model was tested in a separate RCT. The primary hypothesis for each trial was that the attainment of clinical competencies of students part-educated in an SLE would be no worse than that of students educated fully in the traditional clinical immersion model. Secondary outcomes referred to students’ self-reflection on their own growth across competencies. These trials were concerned with the first two levels of Kirkpatrick’s framework of training programme evaluation: the reaction of the student, and the learning outcome.

METHODS

Trial design and participants

Two parallel-group, single-blind, multicentre RCTs were conducted simultaneously, but independently, using a non-inferiority design. Eligible participants were physiotherapy students from six Australian universities, scheduled to undertake a clinical placement in musculoskeletal physiotherapy as part of the clinical education requirements for their entry-level degrees. Participants were drawn from student cohorts at each university in 2009 and 2010. Students volunteered to participate following a presentation about SLEs and a full explanation of the study.

A sample size of 90 students per group in each RCT provided power of 0.95 to detect a difference of 0.4 in mean clinical competence grading between groups for each trial. This analysis employed a two-tailed
alpha of 0.05 and assumed a standard deviation (SD) of 0.8. The SD estimate was drawn from clinical evaluation data for 133 students at one participating university in 2005. A difference of 0.4 represented less than one half of one grading level on the clinical assessment scale, which ranged from 1 to 5, and was used to generate the SD data. Each RCT maintained a power of 0.93 to detect a difference of 0.4 between group means even when incorporating a 10% dropout rate. We planned to accept 92 students per group \((n = 184\) in each RCT) to permit an even division of students across participating universities.

Ethical clearance was gained from the ethics committees of all participating educational institutes and hospitals. All participants provided written informed consent and understood that they would be allocated to either trial and then randomly assigned to the simulated or traditional education group within that trial.

**Interventions**

An SLE programme, equivalent to one clinical education week, was developed as a replica for clinical education in the musculoskeletal field. It consisted of nine patient cases to be portrayed by SPs. Cases represented a variety of conditions of the spine and extremities that are commonly encountered in physiotherapy practice. Treatment timelines, and ethics-related, safety and communication learning interactions were incorporated into the case scenarios. This ensured that students were exposed to elements that would assist them to attain a broad range of clinical competencies. In the process of preparing scenarios, real patients were assessed and treated by experienced physiotherapists, who were not members of the project team. The occasions were videotaped and scripted for SP training. Mock charts, X-rays, props, medical test results and clinical reasoning and reflection tasks were built into the scenarios to replicate the clinical setting.

Two SLE models were designed. In Model 1 (RCT 1), full-time practice within an SLE replaced the first week of the 4-week clinical placement and students spent the remaining 3 weeks in clinical immersion. In Model 2 (RCT 2), the SLE was interspersed with clinical immersion over the first 2 weeks of the 4-week placement (i.e. students’ days in the first 2 weeks were divided equally between the SLE and clinical immersion so that the SLE training provided was equivalent to that in one full-time week) and the remaining 2 weeks were spent entirely in clinical immersion. Dedicated clinical educators were employed by the universities to tutor students in the SLE programmes. The usual clinic or hospital educators tutored students in the clinical venues. The educator : student ratio was 1 : 4 in both the SLE and immersion components.

Students in the control (‘Traditional’) groups in each RCT undertook the traditional learning model involving 4 weeks of full-time clinical immersion. They were tutored by usual clinic or hospital educators at an educator : student ratio of 1 : 4. The SLE and Traditional groups spent equivalent time in the learning environment.

**Outcome measures**

**Primary outcome**

The primary outcome in each RCT was student competency to practise as an entry-level physiotherapist at the end of week 4 of the clinical placement. This was assessed in two clinical examinations, involving: (i) the evaluation and treatment of a new patient, and (ii) a follow-up evaluation and treatment of a patient previously managed by the student. The combined result of these examinations was used in analysis. Assessment was conducted by an independent examiner at each university who was blinded to the SLE or Traditional group allocation of the student, and trained in the use of the assessment tool. To ensure examiner consistency across SLE and Traditional group students at the various sites, each examiner assessed all eight of the students who comprised a trial unit (i.e. four SLE and four Traditional group students).

Each examiner assessed students using the Assessment of Physiotherapy Practice (APP), a tool developed in accordance with the competency standards required for entry-level practice by the Australian Physiotherapy Council. The tool comprises 20 items and assesses performance in seven key areas, concerning: professional behaviour; communication; assessment; analysis and planning; intervention; evidence-based practice, and risk management. Students are rated on a scale of 0–4, on which 0 = ‘infrequently/rarely demonstrates performance indicators’ and 4 = ‘demonstrates most performance indicators to an excellent standard’. The benchmark for comparison was a ‘new graduate physiotherapist’. A category designated ‘N/A’ indicates an element was not assessed. An overall performance score is calculated by summing scores
for each item and dividing by the number of items scored. The tool has been shown to be a valid measure of student competency and to discriminate four levels of competence. In a multicentre national study using 30 pairs of examiners, the APP proved to have high inter-examiner reliability (intraclass correlation coefficient [ICC] = 0.92, 95% confidence interval [CI] 0.84–0.96). The standard error of measurement was low (3.2 APP points on a scale width of 0–80) and the minimal detectable change at 90% confidence was 7.9 (9% of the scale width). The APP is currently used by physiotherapy schools in Australia and New Zealand.

Secondary outcome

The secondary outcome related to student reflection and was measured with a questionnaire developed for this research. It collected information about students’ confidence in relation to three areas of competency concerning: communication; assessment, and management. Students responded to 13 items pertinent to these three standards. Each item was introduced with a statement that began: ‘I feel confident in my ability to […]’. Responses were rated on a 5-point Likert scale, on which 0 = ‘strongly disagree’ and 5 = ‘strongly agree’. All students (SLE and Traditional groups) completed the questionnaire prior to and on exit from the 4-week clinical placement. The SLE groups also completed the questionnaire immediately after the SLE module. In each RCT, the questionnaire was administered to students by a research assistant at each university. Once the RCTs commenced, there were no changes to the trial outcome measures.

Procedure

Standardised patient training

A training programme was conducted for the actors who played the SP roles. It included instruction in communication and the provision of feedback to the student on communication and the development of rapport from a patient’s perspective. Each SP was matched as closely as possible physically and demographically to the patient case he or she was to portray. Each SP was trained using the videotape of the real patient–physiotherapist interaction, as well as a script generated from the video. The SPs received personal instruction from a physiotherapist and supervised practice in portraying the case. As far as it was feasible over the 2-year period, the same SPs portrayed the same patients over the two RCTs at each university.

Assignment and randomisation

All universities participating in the two RCTs contributed similar numbers of students to each trial for up to four trial units in each of RCT 1 and RCT 2 (to give a total of eight units per university) (Fig. 1). The RCTs ran independently but in parallel. It was not feasible to conduct a single three-arm RCT because various constraints prevented the scheduling of 12 students concurrently to accessible musculoskeletal clinical placements. Assignment to either RCT 1 or 2 was not randomised for logistical reasons (e.g. SLE clinical educators needed to know in advance whether they were to work 1 week full-time or 2 weeks half-time). Randomisation occurred within each RCT. The RCTs were conducted within the usual clinical settings, including hospital physiotherapy outpatient departments and university clinics and within each university’s scheduled clinical education programme for the year. A manager, responsible for timetabling clinical education placements at each university, was provided with the list of students in each year who had volunteered for the study in order to assign participants to RCTs 1 and 2. The clinical manager scheduled sets of eight students (a trial unit) to a musculoskeletal placement at times convenient within a university’s overall programme. The units for each RCT were prescheduled in an arbitrary order over the 2 years across all universities. Sets of eight students entered the next scheduled time for one or other RCT.

The randomisation of individual students within each RCT to the SLE and Traditional groups was conducted within each set of eight students at each
Can simulation replace part of clinical time?

Education with SPs took place in the usual clinical environment at a university or hospital. All students participated in the assessment and management of the nine patient cases. Four cases were treated on three occasions, four on two occasions, and one on one occasion, giving a total of 21 patient experiences in the SLE period. Students worked once in a group of four, eight times in pairs and on 11 occasions as the sole practitioner. Learning strategies that are possible only in an SLE were incorporated. For the sole practitioner. Learning strategies that are of four, eight times in pairs and on 11 occasions as in the SLE period. Students worked once in a group one occasion, giving a total of 21 patient experiences three occasions, four on two occasions, and one on the nine patient cases. Four cases were treated on the clinical placement.

**Clinical education in the SLE**

**Ethics considerations**

Procedures were put in place to protect students against any adverse effect on clinical performance or grading for university purposes that might arise as a result of their participation in the RCTs. It was planned a priori that if outcomes for students in the SLE groups were worse than those of students in the Traditional groups, the study would be terminated immediately. Evidence of worse outcomes was defined as a consistent reduction by one or more grades on the APP scale. Results were monitored at each university over the trial period.

**Statistical analysis**

The primary endpoint for the RCTs was at week 4. A non-inferiority test for difference in means was conducted for each trial. The null hypothesis was that the difference between the means of the SLE and Traditional groups would be > 0.4 in APP scores, a margin (Δ) that was regarded as the maximal difference that was not significant in practice. Thus the null and alternative hypotheses for each trial were: null hypothesis: \( \mu_{Trad} - \mu_{SLE} \geq \Delta \); alternative hypothesis: \( \mu_{Trad} - \mu_{SLE} < \Delta \). These hypotheses were tested by calculating the CIs for the difference in means to determine whether the value \( \Delta \) was greater than the upper bound of the 95% CI. Independent-samples \( t \) tests were used to investigate any between-group differences in scores on the seven competencies within the APP tool in each RCT.

For the secondary outcome, the scales for analysis of student ratings for the three competencies were derived from the combined means of the 13 Likert items. These scales were checked for reliability (Cronbach’s \( \alpha \) ranged from 0.77 to 0.9). The non-parametric test suite in sss was used to investigate any group differences in students’ confidence with patients over three (SLE groups) or two (Traditional groups) time-points in each RCT. All analyses were conducted using sss Version 19.0 (SPSS, Inc., Chicago, IL, USA). The level of significance was set at \( p < 0.05 \).

**RESULTS**

The RCTs were completed without interruption in December 2010 once the sample size was reached. Figure 2 illustrates the flow of students through the RCTs. Although 184 students were assigned to each
RCT, on one occasion one unit assigned to Model 2 was mistakenly given Model 1, resulting in 192 students in RCT 1. A replacement group of reserve students was allocated to RCT 2. Three trial units in RCT 2 comprised six rather than eight students as a result of placement and timetabling difficulties, resulting in 178 students in RCT 2. Dropout rates amounted to only 1% in each RCT, although on nine occasions in each of RCTs 1 and 2, students undertook only one of the two clinical examinations for reasons of patient non-attendance. No harmful or unintended effects occurred in either RCT in any student group.

Primary outcomes

RCT 1: SLE Model 1

The mean APP score for the two clinical examinations was 2.73 (standard error [SE] 0.04) in the SLE group and 2.68 (SE 0.04) in the Traditional group. Analysis supported the alternative hypothesis. The 95% CI of the difference in means was −0.07 to 0.17 and the upper bound of this CI is less than the margin of 0.4. The results for the seven key competencies assessed within the APP tool are illustrated in Fig. 5(a); analysis revealed no significant differences (at p < 0.05) in scores between the groups.

RCT 2: SLE Model 2

The mean overall APP score was 2.61 (SE 0.05) in the SLE group and 2.58 (SE 0.05) in the Traditional group. Analysis again supported the alternative hypothesis. The 95% CI of the difference in means was −0.11 to 0.16; the upper bound of this CI was also < 0.4. There were no between-group differences in scores for the seven competencies (Fig. 3b).

Secondary outcome

Table 1 presents SLE students’ self-assessment of their confidence with patients based on their ratings.
for three areas of competency (communication, assessment, management) at three time-points (immediately before and after the simulation experience, as well as at the end of the clinical placement) in both RCTs. To test the change in these measures over time, Friedman’s two-way analysis of variance (ANOVA) by ranks test was used. In both RCTs, SLE students showed a significant change in all measures over time (p < 0.01 in all cases). Inspection of the data indicated that students in both SLE models displayed greatest improvement in self-rated confidence across the three areas immediately after completing the SLE units and their confidence continued to improve over the remainder of the clinical immersion period, albeit at a slower rate. A similar analysis, but this time using Wilcoxon’s matched-pair signed-rank test, was used for the Traditional groups, in which confidence had been measured at two time-points (the start and end of placement). Again, students in both RCTs showed significant change in all measures over time (p < 0.01 in all cases), with confidence increasing at the end of the placement. For both RCTs, the SLE and the matched Traditional groups were compared using the Mann–Whitney U-test for two samples. In only one case was there a significant difference between the two groups (RCT 1, communication measure, at start of placement; p = 0.01). Overall, there was a significant effect of time in students’ self-rated confidence; all groups rated their confidence higher at the end of the placement than at the beginning.
DISCUSSION

Programmes for clinical education in SLEs are increasing in popularity in several health professions. In some jurisdictions, SLEs are beginning to be used to replace part of clinical time with patients as a way of increasing the capacity of health systems to provide clinical training across a range of health disciplines. Yet the evidence for their value as an alternative to traditional real-life clinical practice is sparse. The results of these RCTs indicate that clinical education in an SLE can successfully replace a portion of clinical time (25%) with real patients without compromising student learning outcomes. There was no difference in mean clinical competency scores on the final clinical examinations between the SLE and Traditional student groups in either RCT.

Previous simulation research has provided evidence for effective learning of a particular competency or skill. This research provides evidence that learning in an SLE can contribute to training in all of the key competencies required of future health professionals for total patient care. Notably, no differences were found between the SLE and Traditional groups in either RCT in any competency (professional behaviour, communication, assessment, analysis and planning, intervention, evidence-based practice, risk management). The RCTs involved physiotherapy students in a musculoskeletal ambulatory care setting. However, these core competencies are common to the majority of health professionals and apply across various fields of practice.

The evidence gained from this research supports the growing trend for using well-designed SLEs across the spectrum of medical, nursing and allied health professional education. The national multi-university context of the use of SLEs adds to the robustness of the results.

It is advocated that simulation should be used alongside clinical practice and linked closely with it in order to allow its full potential as a learning aide to be realised. We developed and trialled two SLE models, in one of which the SLE component was conducted immediately prior to students’ entry to clinical practice, whereas in the other the SLE experience was interspersed with clinical practice. In the latter, students spent 50% of the day in each environment for the first 2 weeks of a 4-week placement. The outcomes of both RCTs were similar. Both models were closely linked to clinical practice and the choice of model may ultimately relate to external factors such as the timetabling preferences of the university, placement sites and convenience for students.

All students (in the Traditional and SLE groups) were initially reserved in their confidence about entering clinical practice across the domains of communication, assessment and management. They rated their agreement with statements on confidence that began ‘I feel confident in my ability to […]’ as between ‘undecided’ and ‘somewhat agree’. This is not unusual. Students’ confidence improved significantly and relatively equally in the SLE and Traditional groups in both RCTs, with all ratings shifting to ‘somewhat agree’ and ‘strongly agree’. Students in both SLE models were also surveyed immediately after the SLE experience. The most dramatic improvement in their confidence levels occurred following the SLE, with confidence improving only marginally in the remaining weeks in the clinical environment. This improvement in confidence to interact with patients following training in a ‘safe’ SLE is consistent with findings by others.

Potential limitations of the RCTs must be recognised. There is evidence that training in isolated skills in an SLE (e.g. communication, technical skills) can be superior to that in conventional training, but this was not achieved in this study. The period of time in the SLE (1 week) was relatively short, which may in part explain why no differences were seen between the Traditional and SLE groups. Alternatively, it is not known whether the students in the SLE groups would have gained competencies in the 3-week clinical immersion alone, without the SLE week. We are unable to resolve this issue based on these trials. Nevertheless, there is continuing debate about how many clinical hours are required for students to become competent in a field of practice. The length of each clinical placement for specified fields of practice in physiotherapy in Australian universities has ranged from 4 weeks to 6 weeks. Current practice favours 5-week placements, a decision based on a consensus by clinical educators on the time required by most students to become competent. Therefore, we suggest that the 1-week period in the SLE, which constituted 25% of the total clinical placement, positively contributed to students’ achievement of key professional competencies.

Building on these findings, future research might explore whether superior outcomes can be achieved by allotting more time to the SLE within a clinical...
placement. Research might then progress to determine exactly how much learning can occur in an SLE to make a more significant contribution to increasing clinical capacity.

The fact that students were volunteers introduces a risk for selection bias. The GPA distributions of students who did and did not volunteer at one university were analysed. No difference was evident between the two cohorts (t<sub>0.03</sub> = 1.43, p = 0.16), which gives us some confidence that our student cohort represented the whole student group. The APP tool used to assess clinical competencies has shown validity and reliability and can discriminate different levels of competence. The use of clinical vivas in RCTs demonstrates a student’s clinical competency at a particular time-point and may not be sensitive enough to provide a thorough investigation into the skills acquired. Nevertheless, these conditions were consistent for both the SLE and Traditional groups and should not compromise the primary findings. The questionnaire used for the secondary outcome of student self-reflection on growth in competence was developed for this study by educators with expertise in the relevant constructs of interest. We recognise that it may contain potential sources of measurement error, but it will serve to inform further work.

The use of simulations is not without challenges in the field of musculoskeletal physiotherapy. Standardised patients have limitations, notably in their physical presentations. The SP can be matched demographically with the ‘real’ patient and trained to portray some aspects of the case well, but there are some physical features that SPs cannot simulate. This might be improved by the use of hybrid simulations such as are employed in other fields of practice. Currently, there are no commercially available hybrid simulations suitable for training in the physical examination and management of musculoskeletal disorders, other than low-fidelity static anatomical models that have no real value in this context. Future development of medium- and high-fidelity part-task trainers would undoubtedly enrich the SLE experience in physiotherapy education. The costs of implementing an SLE need to be taken into account. A cost-effectiveness analysis is in progress for this research.

CONCLUSIONS

Simulation will never totally replace real-patient learning experiences in the clinical environment. However, the results of these novel RCTs provide initial evidence that clinical education in an SLE can replace 25% of clinical time with real patients without compromising student learning outcomes, at least in the field of musculoskeletal physiotherapy. Learning in an SLE need not be limited to a particular competency or skill, but can contribute successfully to students’ attainment of all key competencies required of future health professionals.

Contributors: KW and GJ made substantial contributions to the conception and design of the study, the acquisition, analysis and interpretation of data, and the drafting of the article. AW, NM, JM, DR and AJ made substantial contributions to the conception and design of the study, and the acquisition of data. FB, VO’C and RP made substantial contributions to the conception and design of the study. TH made a substantial contribution to the conception and design of the study, and the analysis and interpretation of data. GW made a substantial contribution to analysis and interpretation of data and the drafting of the article and revising it critically for important intellectual content. All authors contributed to the critical revision of the article and approved the final manuscript for publication.

Acknowledgements: we wish to acknowledge the contribution of the following Research Assistants: Lucy Thomas, Liz Paull, Debra Hedlefs, Penny Moss, Airi Repetti, Anneliese Synnot.

Funding: funding was received from an Australian Research Council Linkage Grant (LP0776270). Partnership funding in this ARC Linkage Grant was received from: Physiotherapists Board of Queensland, Australian Physiotherapy Council, and Australian Physiotherapy Association. In kind support was provided by: Queensland Health Clinical Skills Development Centre, Queensland Health, Department of Health Western Australia, Department of Health NSW, and Department of Human Services Victoria.

Conflicts of interest: none.

Ethical approval: this study was approved by the University of Queensland Medical Research Ethics Committee (MREC) (0931120.1), the University of Newcastle Human Research Ethics Committee (HREC) (H-2008-0166), Curtin University HREC (HR39/2007), Griffith University HREC (PES/06/08), James Cook University Human Ethics Sub-Committee (55/08), La Trobe University HREC (08/039), Alfred Hospital Ethics Committee (182/08), Austin Health HREC (H2008/034250), Cairns Base Hospital Ethics Committee (#518), Eastern Health HREC (E55/0809), Gold Coast Health Service District HREC (H200858), Hunter New England HREC (09/04/15/12.01), Melbourne Health (2008.246), Princess Alexandra Hospital HREC (EC00167, 2008/173), Royal Brisbane and Women’s Hospital HREC (EC00172, 2008/058), Sir Charles Gardner Hospital HREC (2009-102), St Vincent Hospital HREC (LRR 163/08) and the Townsville Health Service District Institutional Ethics Committee (55/08).
REFERENCES

Can simulation replace part of clinical time?


Received 19 December 2011; editorial comments to authors 25 January 2012, 14 March 2012; accepted for publication 21 March 2012