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ORIGINAL PAPER

Developing clinical competency in crisis event management: an integrated simulation problem-based learning activity

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Abstract This study aimed to evaluate the integration of a simulation based learning activity on nursing students' clinical crisis management performance in a problem-based learning (PBL) curriculum. It was hypothesized that the clinical performance of first year nursing students who participated in a simulated learning activity during the PBL session would be superior to those who completed the conventional problem-based session. The students were allocated into either simulation with problem-based discussion (SPBD) or problem-based discussion (PBD) for scenarios on respiratory and cardiac distress. Following completion of each scenario, students from both groups were invited to sit an optional individual test involving a systematic assessment and immediate management of a simulated patient facing a crisis event. A total of thirty students participated in the first post test related to a respiratory scenario and thirty-three participated in the second post test related to a cardiac scenario. Their clinical performances were scored using a checklist. Mean test scores for students completing the SPBD were significantly higher than those who completing the PBD for both the first post test (SPBD 20.08, PBD 18.19) and second post test (SPBD 27.56, PBD 23.07). Incorporation of simulation learning activities into problem-based discussion appeared to be an effective educational strategy for teaching nursing students to assess and manage crisis events.

Keywords Simulation · Problem-based learning · Nursing education · Crisis events · Clinical competency

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Introduction

Nurses are often faced with high patient acuities. Patients receiving care in acute general wards are often older, undergoing major surgical procedures or are acutely ill which creates an increase in the acuity and dependency of patients being cared by nurses in general ward areas. The majority of premonitory signs and symptoms of cardiac arrest in patients on medical wards are usually preceded by observable deterioration in the patient's condition but such warning signs and symptoms are frequently missed, mismanaged and/or misinterpreted by nursing and medical staff (Franklin and Mathew 1994). The early recognition and treatment of these signs may prevent the need for cardio-pulmonary resuscitation and ICU admission.

Critical care outreach services and guidelines for detecting critical illness have been developed in many acute hospitals to support ward staff in managing patients at risk. However, it is ultimately ward nurses, who are often the first person to encounter a patient in crisis, and initially manage such critical care situations (Gibson 1997). Ward nurses must be able to assess patient deterioration, evaluate the assessment data, and notify the doctor promptly (McArthur-Rouse 2001). Such knowledge and skills should be addressed in preregistration nursing curricula, rather than post-registration critical care courses.

The Alice Lee Center for Nursing Studies (ALCNS), National University of Singapore, uses a PBL approach to teaching and learning in the undergraduate nursing program. The integration of simulation technology into PBL is seen to provide opportunities for nursing students to integrate theory from PBL sessions into "real life practice situations". The main focus is to develop students' clinical competency for providing safe, competent, timely and appropriate patient care during the management of crisis events.

Although the clinical laboratory and clinical practicum in the preregistration nursing curriculum provide effective learning experiences for nursing students, opportunities for exposure to clinical crises cannot be guaranteed during clinical practice. Technological advancements in nursing education now include the human patient simulator, which can capture a variety of patient conditions and create opportunities for learners to manage emergency situations in a planned and prescribed way. Patient simulation in nursing education has been reported as an effective learning tool (Beyea and Kobokovich 2004; Feingold et al. 2004; Nehring et al. 2001). One of the major strengths of simulation-based learning is that it provides opportunities for problem solving in a clinical situation and integration of knowledge and skills without the fear of harming a real patient.

Problem-based and simulation-based learning are linked closely to the principles of constructivism and collaborative learning making the integration of these strategies possible. Both educational approaches involve working on a case scenario with the problem as the stimulus for learners to construct their own knowledge. Collaborative learning takes place in both instructional strategies as interactions in small group occur among learners and facilitators. The major differences are the learning environment and feedback mechanisms. Unlike problem-based learning, simulation-based learning requires students to role play the case scenario using a patient simulator and medical equipment. The students receive feedback on their performance from the patient monitor, physical assessment and verbal feedback during debriefing. In many PBL formats, students assess and manage the patient described in a written scenario and receive verbal feedback from peers and the facilitator within a group discussion.

A recent review of the literature recommended that simulation-based learning should be integrated into the educational curriculum for optimal results (Issenberg and Scalese 2007). This implies that simulation-based learning should be integrated rather than as an extraordinary or optional activity. Such integration can be achieved without causing any major changes to the course content or timetable (Gordon et al. 2004). In the current study, ALCNS faculty implemented this strategy by transferring some of the time spent discussing case scenarios to role playing in the simulation laboratory.

Although many studies have evaluated the effectiveness of simulation-based learning, there are relatively few experimental studies testing the effect of simulation on clinical performance (Radhakrishnan et al. 2007; Weller 2004). To date, there are no published studies in medical or nursing education that evaluated the implementation of simulation learning with problem-based discussion. Simulation-based learning is known to be associated with significant financial outlay to acquire resources. Therefore, the value and usefulness of simulation technology in problem-based learning has to be explored. The aim of the present study was to evaluate the clinical performance of nursing students who participated simulation training with problem-based discussion in managing crisis events in comparison with those that participated only the problem-based discussion. Two study hypotheses were formulated as follows:

Hypothesis 1: Nursing students who received simulation training with problem-based discussion would have superior clinical performance in managing a patient with respiratory distress than those who underwent only problem-based discussion

Hypothesis 2: Nursing students who received simulation training with problem-based discussion would have superior clinical performance in managing a patient with acute chest pain than those who underwent only problem-based discussion

Method

Design and sample

A quasi-experimental study was conducted. Potential participants were Year 1 nursing students in a Bachelor of Science (Nursing) program, undertaking a nursing module related to care of patient with respiratory and cardiovascular disorders. As the study was conducted within the module, the Year 1 students were assigned by the researcher to either simulation with problem-based discussion (SPBD) group or problem-based discussion (PBD) group based on their pre-assigned tutorial groupings. All students from both SPBD and PBD groups were invited to participate in the test scenarios. The researcher had a meeting with potential participants to explain the nature of the study and request their participation. The participants were asked to sign a written consent prior to data collection and anonymity in the reporting of results was assured.

Instrument

The clinical performances of nursing students were measured using checklists developed by the researcher. Two sets of checklists were developed for the two test scenarios. The checklists consisted of two subcategories: assessment (history and physical examination) and immediate actions. These checklists outlined the essential actions that a Year 1 nursing student might reasonably be expected to perform. The content validity of the checklists was established by a panel of nursing and medical experts and refined after testing with

Table 1 Checklists

Checklist for respiratory scenario post test I	Checklist for cardiac scenario post test II
Assessment	
Ask questions related to chief complaint	Ask questions related to chief complaint(pattern, quality, radiation, severity, time)
Take vital signs	Take vital signs
Perform SpO_2 monitoring	Perform SpO_2 monitoring
Auscultate for breath sound	Auscultate for breath sound
	Auscultate for heart sound
Immediate intervention	
Reassure patient	Reassure patient
Help to sit patient upright	Help to sit patient upright
Deliver oxygen	Deliver oxygen
Check medication record to administer ventolin nebulizer	Perform ECG
Call Dr using SBAR communication tool	Check medication record to administer SL GTN
	Check blood pressure and pain level
	Administer 3 doses of SL GTN at 5 min interval
	Call Dr using SBAR communication tool

2 Year 2 nursing students. A weighting system (score of 1 to 3 points) was used to score checklist items: 1 point for no attempt, 2 points for an unsuccessful attempt and 3 points for a successful attempt. The checklist is shown in Table 1.

Procedure

The intervention phases of the study consisted of core topics of instruction implemented within a module/subject focusing on contemporary nursing practices. All students were given an orientation on the manikin features, opportunities to listen to heart/lung sounds, take a pulse and check blood pressure. Following the orientation, the students underwent two intervention sessions (5 weeks apart), one using SPBD and one using only PBD (See Fig. 1). The students from the two groups (SPBD and PBD groups) were "crossed over" in the two intervention phases, producing two experimental cohorts: (1) One group received respiratory SPBD followed by a cardiac PBD. (2) Another group received a cardiac SPBD followed by a respiratory PBD. By the end of all the intervention phases, all students had received two different teaching methods for each clinical scenario. Thus, no student would be disadvantaged as all received the same content including the two different styles of learning.

Two case scenarios focusing on acute care management for respiratory and cardiovascular issues were developed. The educational content of these case scenarios were based on curricular objectives. Students in both the SPBD and PBD groups worked through the same scenario with a facilitator. All nurse educators, facilitating either the experimental or control groups, were briefed before these educational sessions and received similar tutor guidelines and learning objectives. For all intervention sessions, the same instructors taught all simulation sessions while another group of instructors led all the problem-based discussion.

Both SPBD and PBD groups worked on the case scenario during an hour brainstorming session whereby students attempted to identify clinical problems and develop hypotheses and learning issues through group discussion. Students then had time for self-directed learning to research their assigned "learning issue". Group members reconvened during

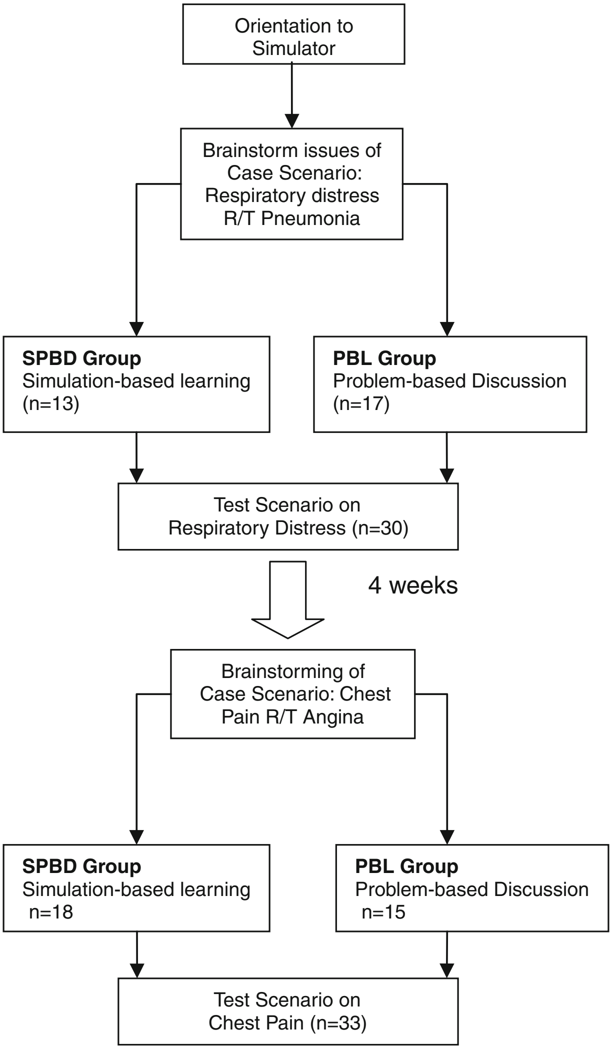

Fig. 1 Study design conceptual flowchart. SPBD = Simulation problem-based discussion; PBL = problem-based discussion

the following week to re-examine the scenarios. The PBD group spent about 1 h 40 min discussing their learning issues and information to resolve the crisis event. The SPBD students were divided into 2 smaller groups (4 students in a group). Each group participate a 20 min hands-on practical simulation experience in managing a crisis event on a SimMan patient simulator. While one group of students completed the simulation exercise, the remaining students observed the scene through live video recording. Each small group simulation role play took about 20 min. This was then followed by an hour of debriefing session in which students discussed the case scenario based on their experiences, how the situation may have been managed more effectively, and integrated findings from the students' self-directed learning. Thus, both PBD and SPBD groups spent an equal amount of time (1 h 40 min) in each learning methodology.

Table 2 Scenarios

Intervention I	Post test I
A 65-year-old post-operative patient, who has undergone lobectomy, developed respiratory distress resulting from COPD exacerbation	A 70-year-old patient with medical history of asthma developed shortness of breath from an acute asthma attack.
Intervention II	Post test II
A 85-year-old patient, with a medical history of chronic cardiac failure and atrial fibrillation, complained of severe chest pain and was found diaphoretic. His ECG revealed acute myocardial infarction.	A 65-year-old patient, with history of ischemia heart disease, was admitted for uncontrolled hypertension. He complained of chest pain to the ward nurse. His condition was classified as stable angina.

Test scenarios for all students using a manikin with simulation capabilities took place one week after each education intervention session. The post-test scenarios were altered from the intervention scenarios to ensure that students were assessed on their application of clinical reasoning and not on their recollection of learned steps. For instance, from the given test scenario, students were required to assess the patient history, perform a physical assessment and carry out appropriate nursing interventions to manage the event (See Table 2).

Students were allocated an individual time for the post-test and two nurse educators, blinded to the education intervention the students received, assessed student performance. For consistency, one was responsible for running the scenario and the other assessed student performance using the checklist. Students' performance was videotaped for the purpose of reviewing for any scoring error. Students received a brief orientation, were given the scenario, and asked to manage the presented case individually. A short debrief took place immediately to discuss the case scenario and consolidate learning. To prevent discussion among students, they were asked to sign a confidentiality agreement. The study received Institutional Human Research Ethics Board approval and was conducted from February to May 2008.

Data analysis

Data were analyzed using statistical package SPSS. The data from the posttest checklists were analyzed using independent *t*-tests to compare the mean scores between experimental and control groups, and missing data were replaced by group mean.

Results

The first experimental cohort who participated in the respiratory test scenario comprised of thirty nursing students (13 from SPBD & 17 from PBD) and were between the ages of 20 and 22 (Mean = 20; SD = 1). There were 33 nursing students (18 from SPBD & 15 from PBD) in the second experimental cohort who participated in the cardiac test scenario. Participants were between the ages of 20 to 22 (Mean = 20.2; SD = .52).

Hypothesis 1: Nursing students who received simulation training with problem-based discussion would have superior clinical performance in managing a patient with respiratory distress than those who underwent only problem-based discussion

Table 3 Comparison on post-test scores for SPBD and PBD group

	SPBD Group ($n = 13$)		PBD Group ($n = 17$)		*T*	*P*
	Mean	SD	Mean	SD		
Scenario 1: Respiratory distress ($n = 30$)						
Assessment score	8.83	0.80	8.19	1.24	1.64	0.113
Immediate action score	11.25	1.64	9.82	2.04	2.06	0.049*
Overall score	20.08	1.93	18.19	2.55	2.23	0.034*
Scenario 2: Chest pain ($n = 33$)						
Assessment score	8.44	1.34	6.93	1.16	3.43	0.00*
Immediate action score	17.44	1.92	14.60	2.06	4.1	0.00*
Overall score	27.56	2.15	23.07	2.69	5.34	0.00*

* $p < .05$

This hypothesis is supported by the findings of this study. As shown in Table 3, means and standard deviations for the performance post-test scores are presented. For the first test scenario on respiratory distress, the SPBD group had an overall mean score of 20.08 (SD = 1.93) and the PBD group 18.19 (SD = 2.55). Although the results indicated that the SBPD group had significantly higher average overall scores than the PBL group ($t = 2.23$; $p = 0.034$), the difference in the overall mean scores between the two groups is very small. There were no significant differences between groups in relation to physical assessment ($t = 1.64$; $p = 0.113$) but marginally significant to immediate action scores ($t = 2.06$, $p = 0.049$).

Hypothesis 2: Nursing students who received simulation training with problem-based discussion would have superior clinical performance in managing a patient with acute chest pain than those who underwent only problem-based discussion

This hypothesis is supported by the results of the study. As displayed in Table 3, for the second test scenario (chest pain), overall post-test scores showed that the SPBD group had a significantly higher overall mean score of 27.56 (SD = 2.15) than the PBD group (mean of 23, SD = 2.69) ($t = 5.34$, $p = 0.01$). The SPBD group had statistically significant higher scores than the PBD group on subcategories for both physical assessment ($t = 3.43$, $p = 0.01$) and immediate actions ($t = 4.1$, $p = 0.01$) in the posttest on chest pain.

Discussion

Our study demonstrated that performance scores of students in managing crisis events were higher in the SPBD group than those in PBD group. Integrating simulation learning into problem-based learning facilitated acquisition of clinical competence compared with conventional problem-based learning. The results also indicated that students who completed simulation activities have higher performance scores for assessment and provide immediate actions before the arrival of the doctor. The skills of assessment are important for nurses to identify early warning signs of critical illness so that they are able to intervene promptly. The immediate actions to manage patients' airway, breathing and circulation may help to prevent further deterioration of patients' condition to the point where cardio-pulmonary resuscitation may become necessary (McArthur-Rouse 2001).

There was a small (1.89) but statistically significant difference in the overall mean scores on the respiratory test scenario between the SPBD and PBD groups. This small difference was due to the fact that the subcategory assessment scores being not statistically significant different between the two groups. This may be explained by the simplicity of the tasks required for assessing patient with respiratory distress. Another explanation could be that the students have had experiences with this form of physical assessment before the study.

T-test values obtained in the first test scenario ($t = 2.23$, $p = 0.034$) were lower than those obtained for the second test scenario ($t = 5.34$, $p = 0.01$). A possible explanation could be that the list of tasks for managing patient with chest pain required more complex nursing actions to be executed compared to clinical actions in the care of patients with respiratory distress. Another possible reason could also be that the intervention and post-test for the respiratory case scenario was undertaken before the cardiovascular case scenario (a month apart). Thus, factors such as improved teaching skills of the simulation facilitators gained from the respiratory case scenario and improved knowledge and skills acquired by students from the ongoing lecture and laboratory skills classes could have resulted in better performances by students in the cardiovascular case scenario.

Several studies have used a randomized controlled trial design to compare simulation-based learning with problem-based discussion but their findings were controversial (Steadman et al. 2006; Wenk et al. 2008). Wenk et al. (2008) demonstrated that both problem-based discussion and simulation-based teaching have comparable outcomes in theoretical knowledge and clinical skill. Steadman et al. (2006) found simulation base learning to be superior to problem-based learning in the context of critical assessment and management skills acquisition. However, neither study focused on the theoretical basis for PBL. Dolmans et al. (2005) in their review of PBL concluded that future research should focus on developing and improving PBL to bridge theory and practice. Our study demonstrated that the incorporation of the clinical performance of simulation with a theoretical emphasis of problem-based discussion further improved PBL processes and resulted in improved clinical competence.

There are several reasons why the integration of simulation into problem-based discussion could result in superior performance. One reason is that simulation provided learners with the opportunity to practice their clinical skills in a realistic and non-threatening environment. This allowed them to review and practice their skills and develop a systematic approach to the management of a crisis event (Weller 2004). In the present study, the opportunity for the experimental group students to participate in simulation, after their clinical skills laboratory, allowed them to engage in repetitive practice. Repetitive practice is crucial for clinical skill acquisition as it makes skill demonstration effortless and automatic (Issenberg et al. 2005). A study done by Alinier et al. (2006) demonstrated the effectiveness of intermediate-fidelity simulation in development of nursing students' clinical skills performances. In addition to clinical skills performance, the present study also required students to manage crisis events which require cognitive abilities including clinical reasoning skills.

In addition to the development of practical skills, simulation may facilitate contextual, constructive and active learning. The transfer of learning from paper case to realistic clinical situation through simulation may enhance the contextual nature of learning in PBL. The clinical experiences gained from simulation allowed students to link these experiences to the discussion of the problem. This enabled the students to build more personal interpretations of the problems and thus, contributed to the enhancement of the problem-based discussion (Mamede et al. 2006). Simulation, which involves a variety of learning strategies such as role playing, viewing videos and discussion, further enhance learning in PBL environment by making learning more engaging for students. Jeffries (2002) stated that the use of a variety of learning strategies in simulation can accommodate the diverse learning styles of nursing students which is an important pedagogical principle of good teaching. According to Hodgson (1997), learning is deepened when learners are able to perceive the meaning and intrinsic relevance of the subject matter to their own purposes. Immersion into the nursing role in simulation provides students with valuable insights on the relevance of their clinical skills and knowledge to their field of work.

While the integration of simulation into PBL not only enhanced the process of PBL discussion, the PBL process itself could foster simulation learning processes. In conventional simulation-based learning, a case scenario is normally presented to students immediately before they commence their simulation role play, and their post simulation discussion is based on the experiential learning gained from the simulated role play. However, the integration of simulation into PBL in the current study provided students with opportunities to explore the case scenario in-depth. The theoretical knowledge gained from the PBL brainstorming of the case scenario and self-directed learning could have facilitated the transition of theoretical knowledge into students' clinical performances during the simulation role play and encouraged the application and synthesis of knowledge during post-simulation discussion.

Feedback mechanisms could also explain the effectiveness of simulation with problem-based discussion compared to problem-based discussion. There are various sources of feedback incorporated into simulation training. These include direct feedback from the simulator based on learners' actions, verbal feedback from facilitator and critical review of the recorded role play. Students who engaged in problem-based discussion, on the other hand, received only verbal feedback from their peers and facilitator. Issenberg and Scalese (2007) identified feedback as one of the most important features of simulation to enhance effective learning. Feedback slows the decay of acquired skills and allows learners to self assess and monitor their progress towards skills acquisition (Issenberg and Scalese 2007).

Although a similar set of learning objectives were given for both SPBD and PBD, the learning activities during problem-based discussion may not have adequately covered management of the crisis events. This could be largely due to the self-directed learning process embedded in problem-based learning which encouraged learners to determine the learning issues to be discussed and the role of tutor as facilitator. Dolmans et al. (1993) identified that in problem-based learning environments, students' learning activities covered an average of 64% of intended course content. The role of the tutor in problem-based discussion is not to transmit knowledge but probe students' knowledge deeply to stimulate activation and elaboration of their prior knowledge and problem-solving skills (Dolmans et al., 2005). The use of simulation in the current study allowed facilitators to foster learning, monitor and direct students' role playing and evaluate students' clinical performance during debriefing.

Limitations

The study used a homogenous convenience sample of year 1 nursing students that limits generalization of results. As the study was conducted within an existing module of study, the random allocation of students into the SPBL and PBL groups could not occur. A pretest to evaluate the students' performances was also not conducted due to time and logistic issues. The institutional ethics review board did not approve the inclusion of a third group of students to act as control. This study was limited to students' clinical performance. It did not evaluate other outcomes such as knowledge and self efficacy. Thus, future randomized controlled trails could assess additional outcome measures to provide more objective evidence on the use of simulation in problem-based learning. As simulation technologies have been widely used as an assessment tool for clinical competency, a simulation-based evaluation exercise using patient simulator was chosen to be used in the post test study. The improved performance on the simulator, however may not necessary translate into improved performance in clinical settings. Unlike the controlled simulation environment, the clinical performances in the clinical setting can be influenced by many factors such as a chaotic situation that is outside the nurses' control.

Conclusion

Nurses need to be prepared and competent in identifying patients at risk of cardio-respiratory crises and implement immediate management interventions. Education plays an important role in developing this clinical competency. Our study found that the use of simulation with problem-based discussion provided a more effective way for students to learn how to identify and manage a crisis event compared with the use of problem-based discussion alone. Simulation creates opportunities for students to experience a clinical situation and such clinical experiences can enhance the development of PBL by stimulating students towards contextual, constructive and active learning. The results of our study give support for the inclusion of simulation-based learning into PBL. This may require transferring some of the time spent discussing case scenarios during problem-based discussion to role playing in the simulation laboratory. As well as using a randomized controlled trial design, future research should consider additional outcome measures including long-term retention of knowledge and clinical performance as objective measures to support the integration of simulation into problem-based learning.

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