



ELSEVIER



Featured Article

Simulation Exposure Improves Clinical Skills for Postgraduate Critical Care Nurses

Joannet Hardenberg, MN, GradDipEd, GradDipCritCare, Nursing Academic^{a,*,*},
Indrajeetsinh Rana, PhD (Medical Science), MSc, BSc, Senior Technical Officer^{b,*},
Kathleen Tori, PhD, MHSc, MNP, CCRN, GradDip VET, MACN, FACNP, Emergency
Nurse Practitioner^{c,*}

^aDepartment of Rural Nursing and Midwifery, La Trobe Rural Health School, La Trobe University, Bendigo, Victoria, Australia

^bVictoria University, Melbourne, Australia

^cUniversity of Tasmania, Launceston, Australia

KEYWORDS

High-fidelity simulation;
Postgraduate critical care nursing;
Respiratory simulation scenario;
Mannikin simulator;
Critical skills assessment

Abstract

Introduction: Simulation training is a widely accepted tool to improve clinical skills for critical care nurses. Several studies have demonstrated the benefits of simulation training in the arena of postgraduate nursing. To our knowledge, quantitative evidence supporting the benefits of simulation training on critical care students' clinical performance is lacking.

Method: In this study, participants enrolled in postgraduate studies were exposed to an immersive simulation hurdle that mirrored a real-life emergency scenario. Four skill categories addressing clinical performance were used. All participants received theoretical underpinnings related to the clinical hurdle via a conventional teaching method. Participants were then randomly categorized into control and test groups. The test group was involved in simulation activities before the hurdle assessment, whereas the control group attempted the simulation hurdle without prior exposure. Data were collected by an independent assessor using a customized tool.

Results: This study demonstrated a significant improvement in two clinical areas in the test group compared with the control group. This improvement, however, was restricted to "focused patient assessment" and "emergency intervention" skills. There was no significant difference in the skill sets of "primary response" and "consultation with doctor."

Cite this article:

Hardenberg, J., Rana, I., & Tori, K. (2019, March). Simulation exposure improves clinical skills for postgraduate critical care nurses. *Clinical Simulation in Nursing*, 28(C), 39-45. <https://doi.org/10.1016/j.ecns.2018.12.007>.

© 2019 International Nursing Association for Clinical Simulation and Learning. Published by Elsevier Inc. All rights reserved.

In Australia, registered nurses who have completed postgraduate studies in critical care are an integral part of health care provision in the acute sector. Increasing patient acuity, an ageing population, and a growing prevalence of chronic

*All authors contributed equally to this paper.

* Corresponding author: J.Hardenberg@latrobe.edu.au (J. Hardenberg).

illness demand a highly skilled workforce (Australian Institute of Health and Welfare, 2017; Cooper et al., 2010; Harris & Chaboyer, 2002). Education gained is no longer a result of only classroom-acquired knowledge through conventional modalities. Rather, critical thinking skills and clinical practices are obtained through opportunities such as simulation experiences (Buykx et al., 2012; Weller, Nestel, Marshall, Brooks, & Conn, 2012).

Key Points

- There is evidence to suggest that single simulation exposure improves clinical performance.
- Simulation-based education may not target all desired skill areas.
- Ongoing research into postgraduate nursing immersive simulation is required to ensure positive learning outcomes.

University curricula are challenged with finding ways to prepare graduates who have the skills and readiness to work safely in high-acuity clinical settings. Advanced assessment skills and the ability to prioritise care and respond to diverse clinical challenges are a necessary focus of nursing programs. Simulation shows promise as a pivotal

learning modality within this speciality. Simulation learning environments are being increasingly regarded as an important educational intervention to augment and optimise skills acquisition for nurses (McKenna et al., 2011).

Simulation has been used within the nursing field for a number of years (Aebersold & Tschannen, 2013; Mould, White, & Gallagher, 2011). The level of competence in any particular clinical skill and nonclinical skill is dependent on the area of speciality for nurses (Ballangrud, Persenius, Hedelin, & Hall-Lord, 2014). Consequently, the benefit of simulation may also differ depending on the specialization. A study by Ford et al. (2010) demonstrated a positive impact of simulation exposure on medication administration within the critical care setting reporting a 70% reduction in medication errors.

Contemporary research into the undergraduate domain has reported the following benefits of simulation learning environments: improved clinical skills, critical thinking application, communication, and confidence (Archer, 2010; Jansson, Kääriäinen, & Kyngäs, 2013; Melba Sheila D'Souza, Chavez, Kader, & Jacob, 2017). Self-report survey methodology has been the chosen approach for most of these studies. As a means of data collection, surveys may present limitations in that they rely on participant perception. A study by Ballangrud et al. (2014) compared participant self-assessment to independent expert assessors. The authors noted a significant difference between the two in the areas of leadership and resource utilisation. The popularity of self-report

methodology is at least in part due to the lack of availability of validated high-fidelity simulation (HFS) assessment tools.

When first adopted as a learning strategy for health professionals, simulation was limited to the use of anatomical models, case studies, and role-play (Leigh & Hurst, 2008). Today, patient simulation manikins, capable of producing human-like physiological responses and/or symptoms, have significantly improved the realism of clinical case scenarios (Curtin, Finn, Czosnowski, Whitman, & Cawley, 2011; Goolsby, Goodwin, & Vest, 2014; Mould et al., 2011; Zarifanaiey, Amini, & Saadat, 2016). High-fidelity simulation using interactive manikins provides opportunities for nursing students to develop confidence and practise safely in clinical settings (Lapkin & Levett-Jones, 2011; Leigh & Hurst, 2008). These simulation experiences have proved effective in the development of competence in technical and nontechnical nursing skills such as team work and communication with patients (Buykx et al., 2012). Although there is significant evidence of the benefits of simulation within undergraduate programs, less publications are available supporting the inclusion of simulation within postgraduate nursing curricula (Kelly & Fry, 2013; Norman, Dore, & Grierson, 2012).

The impact of HFS on postgraduate critical care skills development within the university setting has received little attention. These skills include patient assessment and communication with medical staff in situations where rapid decision making is vital. In addition, graduates are required to develop technical proficiency to implement emergency interventions. To our knowledge, assessment using simulation to quantify improvement in these skill sets has not been formally utilised. This study addresses the impact of simulation on participants' abilities to demonstrate the aforementioned skills using the following categories: "focused patient assessment," "primary response," "consultation with the doctor," and "emergency management intervention."

Aim

The aim of this study was to quantitatively assess the impact of HFS training on four vital skill areas: "focused patient assessment," "primary response," "consultation with the doctor," and "emergency management interventions" in postgraduate critical care nursing students.

Ethics Approval

This study was approved by the University Human Research Ethics committee before recruitment of participants. Participants were assured of anonymity within the participant statement.

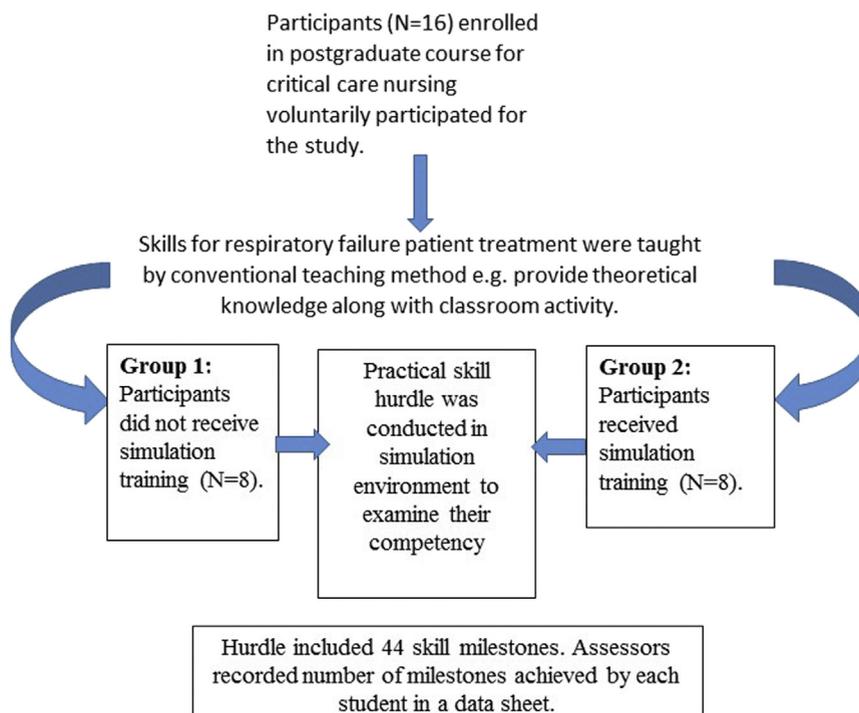


Figure 1 Research design.

Method

A quantitative design was chosen within the context of critical skills acquisition at simulation intensive workshops. [Figure 1](#) provides a representation of how the study was designed and incorporated into the curriculum. The study targeted nurses enrolled in their first year of a Master of Nursing (critical care). Participants were all qualified registered nurses, who had chosen to specialise and who were employed within critical care areas at the time.

After being presented with a formal information statement and acquiring consent, participants were randomly assigned to either the test ($n = 8$) or control group ($n = 8$). For the purpose of this research, the test group was the group who received the intervention of a training simulation. Each participant was designated an identification code against which data were recorded to ensure anonymity.

Five weeks after commencement of the academic year, participants attended a workshop which addressed a number of important learning outcomes within the curriculum. The topic of interest was management of the deteriorating respiratory patient with subtopics as follows: primary response, focused patient assessment, consultation with medical staff (handover of immediate problems), and emergency intervention. All participants had received theoretical underpinnings to the aforementioned topics by way of online modules to be completed before the simulation which included readings and all attended a face-to-face lecture on the day.

Following the aforementioned face-to-face lecture, the test group was exposed to a training simulation over a period of 90 minutes. This session included two stations with a facilitator who had no knowledge of the research study in attendance at each activity. Participants attended each station in groups of 2 to 3. The first training simulation station presented students with a human simulation manikin moulded to resemble a critically ill patient in respiratory distress. Vital signs, chest auscultation, charts populated with trends, fluid balance, pathology and medications along with a chest X-ray, arterial blood gases, further pathology results, and an ECG provided on request. This gave participants the opportunity to perform an assessment, interpret findings, and implement some immediate measures such as patient positioning and escalation of oxygen therapy, effectively the ability to use critically thinking skills within a designated “safe” clinical environment. In conclusion to this segment of the simulated scenario, participants were required to document findings and present a handover to the facilitator.

The second station within the training simulation to which the test group attended involved airway preparation, the access of correct intubation equipment, and the appropriate dosage, timing, and administration of induction/intubation agents while assisting the facilitator with an intubation. The aforementioned session was prepared with the intended learning outcomes and expected responses (milestones) depicted within the assessment respiratory simulation to follow. All participants from both

Table 1 Summary of All Milestones

Skill	Milestones	Total Number
Focused patient assessment	Students were to introduce self, conduct safety checks, Airviva and suction in working order, primary survey of airway, breathing, circulation, neurological assessment, vital signs, and auscultate chest.	10 milestones available
Primary response (with further systems assessment)	Included sitting patient upright, ongoing communication, commence oxygen therapy and escalate as required, further systems assessment, review vitals, documentation, request appropriate diagnostics (chest X-ray/arterial blood gases/attach electrocardiogram leads), and ongoing monitoring.	12 milestones available
Consultation with the doctor (communication of primary concerns to establish plan of action)	Communication with consultant, required to give comprehensive handover (identify self, role, patient, admission diagnosis, interventions to date and response), actions taken to date, contraindications, and request review and intervention to prevent further deterioration.	7 milestones available
Emergency management intervention (setup for intubation)	Access resuscitation trolley, attach defibrillation ECG leads, collects ETT and checks cuff, preparation of intubation equipment (syringe, ETT tape, lubricant, stylet, laryngoscope, ensure suction ready, Airviva, and oxygen) and intubation medications (induction, sedative, and paralytic).	15 milestones available

the test and control groups were exposed to a final immersive assessment scenario. This allowed comparison between the two groups to determine the impact of the training simulation. None of the control group participants were exposed to the aforementioned training simulation before attending the immersive assessment scenario. They did however have opportunity after assessment to engage in the training simulation to ensure that they were not precluded from this component of the critical care curriculum.

This immersive assessment scenario depicted a patient in respiratory failure (see [Appendix 1](#) for a simplified version of scenario). During each individual scenario, an independent assessor recorded a series of expected participant responses (milestones) on an observation tool. The tool included 44 milestones grouped into primary response, focused patient assessment, consultation with the doctor, and emergency intervention. The scenario was concluded after the participant had collected the necessary equipment for intubation or at the 20-minute mark. Before incorporating the immersive assessment scenario into the study, university and clinical educators met to establish important parameters to be included in the assessment tool. The assessment tool or rubric was refined by observing and filming volunteer critical care staff. The [Australian College of Critical Care Nurses, Practice Standards \(3rd Ed. 2015\)](#), was referred to in the process.

Data Collection

As shown in [Table 1](#), a total of 44 milestones were collected under four separate skills categories. The data

were collected by an independent assessor who was unfamiliar with the student group and simulation training being presented. This was to prevent potential bias. To allow reference after assessment, each scenario was also captured on camera. Completed tools and individual films were deidentified and filed under participant codes.

Statistical Analysis

Data were presented as mean \pm SEM. For comparisons between the two groups, unpaired Student's t-test was used for parametric data and Mann–Whitney test for nonparametric data. All statistical analysis was performed using Graph Pad Prism 5 (Version 6.04, La Jolla, CA). Figures for graphical presentation have been prepared using the same software.

Results

More participants from the test (intervention) group achieved a higher number of milestones. Compared to the control group, the test group achieved 15% more milestones. However, this did not attain statistical significance ([Figure 2A](#), $p = .25$, unpaired student's t-test). Categorising participants based on number of milestone achievement showed that 50% of the participants from the control group in contrast to 87.5% participants from the test group achieved more than 20 milestones. Thus, the group that received the training simulation had a greater number of participants who were higher achievers.

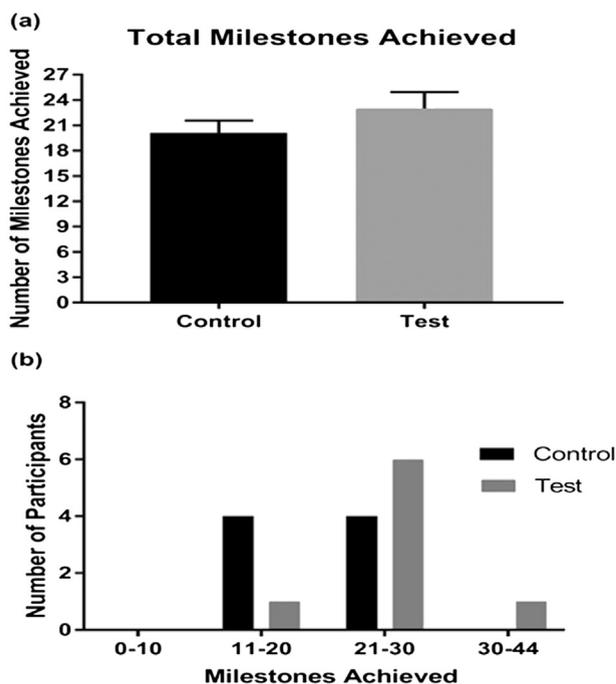


Figure 2 (A) Shows average number of milestones achieved by each participant in the control and test groups. (B) Shows distribution of control and test group participants across the four categories based on the number of milestones achieved.

“Focused patient assessment” and “emergency management intervention” skills were improved following the training simulation. Compared to the control group, the test group achieved 37.5% more milestones for the category, “focused patient assessment” ($p < .05$, Figure 3A). Similarly, the test group achieved 37.14% more milestones as compared to the test group for the category, “emergency management intervention” ($p < .05$, Figure 3B).

“Primary response” and “consultation with the doctor” skills were not altered by simulation exposure. For “primary response” and “consultation with the doctor” skills, there was no significant difference between the number of milestone achieved by participants from both groups. For the “primary response” category, the control group achieved 4.5 ± 0.59 milestones and the test group achieved 4.25 ± 0.88 (Figure 3C). For the category “consultation with the doctor,” the control group achieved 5.75 ± 0.41 milestones and the test group achieved 5.71 ± 0.18 (Figure 3D).

Discussion

In the present study, we assessed the benefits of a single exposure to simulation aimed at improving clinical skills (“primary response,” “focused patient assessment,” “consultation with the doctor,” and “emergency management intervention”), in comparison to conventional teaching methodology of online activities followed by a lecture. We report that a single simulation exposure was able to

improve participant performance when conducting a “focused patient assessment” and implementing “emergency management intervention.” By contrast, participant’s performance in the areas of “primary response” and “consultation with the doctor” did not improve.

We found a nonsignificant increase in the total number of milestones achieved by the participants exposed to simulation (Figure 2A). Data demonstrate that 88% of participants of the control group were unable to gain a score of greater than 50% of the total milestones. Only 12% of the test group participants achieved such a low score (Figure 2B). There are a number of published studies that address the impact of HSF on nursing knowledge levels and clinical performance (Hegland, Aarlie, Stromme, & Jamtvedt, 2017; Langdon & Cunningham, 2007). A newly published study by D’Souza et al. (2017) reported improvement in knowledge and performance scores when comparing HFS to video-based learning (Melba Sheila D’Souza, 2017). Their research focused on undergraduate nurses and did not present specific critical skills. Our research depicted improvement in clinical performance within two critical skill sets, “focused patient assessment” and “emergency management intervention” using an independent assessor to observe participant performance.

In this study, we chose “focused patient assessment” as one of the critical skills required when responding to an acutely unwell patient. Critical care nurses are required to use a systematic, standardised approach beginning with airway, breathing, circulation, and exposure (Aitken, Marshal, & Chaboyer, 2015; Urden, Stacy, & Lough, 2017). This allows them to rapidly identify obvious, as well as tenuous changes in a patient’s condition. Our results suggest a significant improvement (35.7%) in participants’ abilities to perform a “focused patient assessment” after exposure to simulation ($p < .05$, Figure 3A). A study on medical students by Steadman et al., 2006 reported improvement in critical assessment skills when simulation-based training was adopted as opposed to interactive problem-based learning (Steadman et al., 2006). Johnson, Corrigan, Gulickson, Holshouser, and Johnson (2012) reported an improvement in anaesthesia nurse rapid assessment and intervention performance when exposed to simulation training in comparison to lectures alone. Our study is the first to demonstrate the impact of simulation on focused assessment skills for post-graduate critical care nursing students.

We report that simulation significantly improves emergency management skills (27% vs. control, $p < .05$, Figure 3B). Hubert, Duwat, Deransy, Mahjoub, and Dupont (2014) reported an improvement in emergency management intervention skills during difficult intubation scenarios when anaesthetic residents were exposed to simulation training. Other studies have also reported positive impacts of simulation on clinical management skills for fourth-year medical students (Steadman et al., 2006) and emergency intervention clinical skills in anaesthetic nurses (Johnson et al., 2012). A more recent study by Jonson,

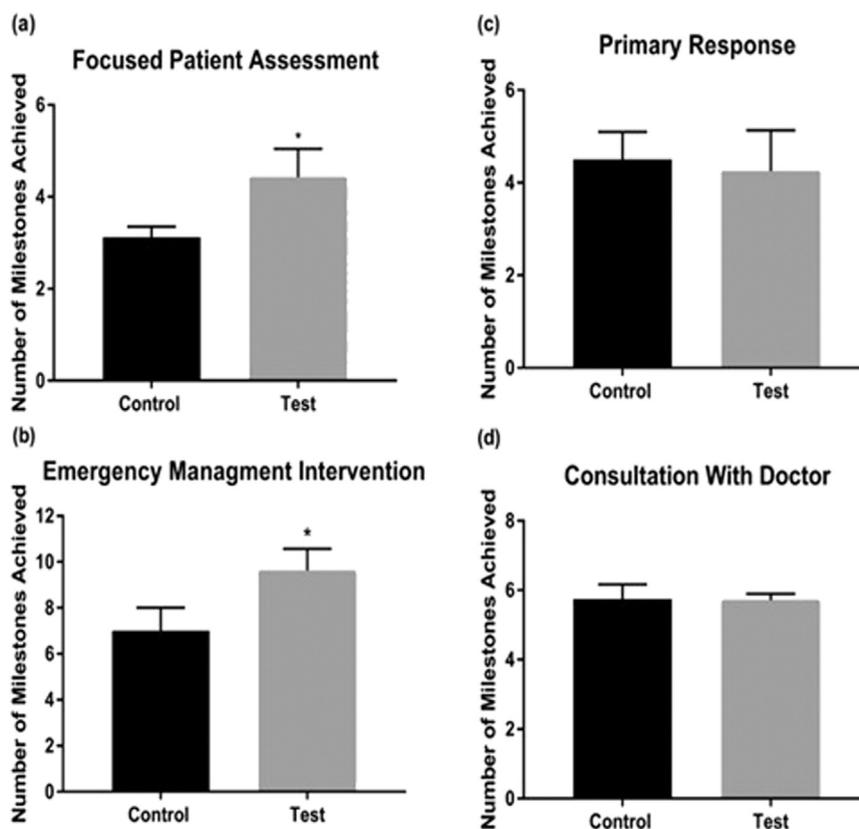


Figure 3 The average number of milestones achieved by participants in the control and test groups for the following skills categories; (A) Focused patient assessment; (B) Primary response; (C) Emergency management intervention; (D) Consultation with Doctor.

Pettersson, Rybing, Nilsson, and Prytz (2017) described the impact of training using the Dig Emurgo simulation system on emergency nurses' self-efficacy scores. Although reported improvement in self-efficacy is used to study clinical improvement, it draws conclusions around association rather than actual observed clinical performance. Our study is the first to demonstrate improvement in emergency management intervention skills in postgraduate critical care nursing students. In addition, our study was the first to use a dedicated observation tool to assess skills in the postgraduate simulated clinical environment.

Our educational intervention using simulation did not alter participant competence in the two areas of “primary response” and “consultation with the doctor” (Figure 3C,D). This is an inconsistent finding as a number of studies have been published presenting positive outcomes in interdisciplinary communication, collaboration, and initial response to a deteriorating patient scenario (Lee, Mucksavage, Canales, McDougall, & Lin, 2012; Pascual et al., 2011; Theilen et al., 2013). Interestingly, the data indicate that the participants from both intervention and control groups entered the study with similar competence levels in these two skills. It appears that neither group consisted of individuals who presented with an advantage of greater exposure outside the study in their clinical settings. Further research is needed to identify

simulation interventions that can influence these two skills in the critical care clinical environment.

Limitation of the Study

Limitations of this study include a modest sample size and the inability to control the entry level of competence of participants. Participants were subjected to an immersive assessment simulation hurdle on an individual basis, and as such, their performance in a team environment may vary. We had no control over participants gaining additional clinical exposure outside this study.

Conclusion

Our research provides clear evidence for HFS as a useful learning tool in the arena of postgraduate critical care nursing. Simulation allows learners to practise clinical skills in a safe environment. A single exposure to a training simulation can impact the skills area of “focused patient assessment” and “emergency management intervention.” Consequently, incorporation of simulation training to address pertinent learning outcomes such as described within this research is an important consideration for future critical

care postgraduate nursing curricula. Further research is required to identify if reported improvements in simulated environment can be translated to the clinical practice.

Acknowledgments

The authors would like to acknowledge the La Trobe Rural Health School Nursing Simulation team and the participants who volunteered for this study.

References

- Aebersold, M., & Tschannen, D. (2013). Simulation in nursing practice: The impact on patient care. *The Online Journal of Issues in Nursing*, 18(2), 6.
- Aitken, L., Marshal, A., & Chaboyer, W. (2015). *ACCCN's Critical Care Nursing* (3rd ed.). Australia: Elsevier.
- Archer, E. (2010). Fresh Simulation options in critical care nursing education. *African Journal of Health Professions Education*, 2(2), 29.
- Australian College of Critical Care Nurses (ACCCN). (2015). *Practice Standard for the Critical Care Nurse* (3rd Ed). Melbourne, Australia: ACCCN. Surrey Hills.
- Australian Institute of Health and Welfare. (2017). *Australian Institute of Health and Welfare 2017: Australia's welfare series no. 13*. Canberra: Australian Institute of Health and Welfare.
- Ballangrud, R., Persenius, M., Hedelin, B., & Hall-Lord, M. L. (2014). Exploring intensive care nurses' team performance in a simulation-based emergency situation, - expert raters' assessments versus self-assessments: An explorative study. *BMC Nursing*, 13(1), 47. <https://doi.org/10.1186/s12912-014-0047-5>.
- Buykx, P., Cooper, S., Kinsman, L., Endacott, R., Scholes, J., McConnell-Henry, T., ..., & Cant, R. (2012). Patient deterioration simulation experiences: Impact on teaching and learning. *Collegian*, 19(3), 125-129.
- Cooper, S., Kinsman, L., Buykx, P., McConnell-Henry, T., Endacott, R., & Scholes, J. (2010). Managing the deteriorating patient in a simulated environment: Nursing students' knowledge, skill and situation awareness. *Journal of Clinical Nursing*, 19(15-16), 2309-2318. <https://doi.org/10.1111/j.1365-2702.2009.03164.x>.
- Curtin, L. B., Finn, L. A., Czosnowski, Q. A., Whitman, C. B., & Cawley, M. J. (2011). Computer-based simulation training to improve learning outcomes in mannequin-based simulation exercises. *American Journal of Pharmaceutical Education*, 75(6), 113. <https://doi.org/10.5688/ajpe756113>.
- Ford, D. G., Seybert, A. L., Smithburger, P. L., Kobulinsky, L. R., Samosky, J. T., & Kane-Gill, S. L. (2010). Impact of simulation-based learning on medication error rates in critically ill patients. *Intensive Care Medicine*, 36(9), 1526-1531. <https://doi.org/10.1007/s00134-010-1860-2>.
- Goolsby, C. A., Goodwin, T. L., & Vest, R. M. (2014). Hybrid simulation improves medical student procedural confidence during EM clerkship. *Military Medicine*, 179(11), 1223-1227. <https://doi.org/10.7205/MILMED-D-14-00072>.
- Harris, D., & Chaboyer, W. (2002). The expanded role of the critical care nurse: A review of the current position. *Australian Critical Care*, 15(4), 133-137.
- Hegland, P. A., Aarlie, H., Stromme, H., & Jamtvedt, G. (2017). Simulation-based training for nurses: Systematic review and meta-analysis. *Nurse Education Today*, 54, 6-20. <https://doi.org/10.1016/j.nedt.2017.04.004>.
- Hubert, V., Duwat, A., Deransy, R., Mahjoub, Y., & Dupont, H. (2014). Effect of simulation training on compliance with difficult airway management algorithms, technical ability, and skills retention for emergency cricothyrotomy. *Anesthesiology*, 120(4), 999-1008. <https://doi.org/10.1097/ALN.000000000000138>.
- Jansson, M., Kääriäinen, M., & Kyngäs, H. (2013). Effectiveness of simulation-based education in critical care nurses' Continuing education: A systematic review. *Clinical Simulation in Nursing*, 9(9), e355-e360. <https://doi.org/10.1016/j.ecns.2012.07.003>.
- Johnson, D., Corrigan, T., Gulickson, G., Holshouser, E., & Johnson, S. (2012). The effects of a human patient simulator vs. a CD-ROM on performance. *Military Medicine*, 177(10), 1131-1135.
- Jonson, C. O., Pettersson, J., Rybing, J., Nilsson, H., & Prytz, E. (2017). Short simulation exercises to improve emergency department nurses' self-efficacy for initial disaster management: Controlled before and after study. *Nurse Education Today*, 55, 20-25. <https://doi.org/10.1016/j.nedt.2017.04.020>.
- Kelly, M. A., & Fry, M. (2013). Masters nursing students' perceptions of an Innovative simulation education experience. *Clinical Simulation in Nursing*, 9(4), e127-e133. <https://doi.org/10.1016/j.ecns.2011.11.004>.
- Langdon, M. G., & Cunningham, A. J. (2007). High-fidelity simulation in post-graduate training and assessment: An Irish perspective. *Irish Journal of Medical Science*, 176(4), 267-271. <https://doi.org/10.1007/s11845-007-0074-2>.
- Lapkin, S., & Levett-Jones, T. (2011). A cost-utility analysis of medium vs. high-fidelity human patient simulation manikins in nursing education. *Journal of Clinical Nursing*, 20(23-24), 3543-3552.
- Lee, J. Y., Mucksavage, P., Canales, C., McDougall, E. M., & Lin, S. (2012). High fidelity simulation based team training in urology: A preliminary interdisciplinary study of technical and nontechnical skills in laparoscopic complications management. *The Journal of Urology*, 187(4), 1385-1391. <https://doi.org/10.1016/j.juro.2011.11.106>.
- Leigh, G., & Hurst, H. (2008). We have a high-fidelity simulator, now what? Making the most of simulators. *International Journal of Nursing Education Scholarship*, 5(1), 1-9.
- McKenna, L., Bogossian, F., Hall, H., Brady, S., Fox-Young, S., & Cooper, S. (2011). Is simulation a substitute for real life clinical experience in midwifery? A qualitative examination of perceptions of educational leaders. *Nurse Education Today*, 31(7), 682-686. <https://doi.org/10.1016/j.nedt.2011.02.014>.
- Melba Sheila D'Souza, R. V., Chavez, F. S., Parahoo, K., & Jacob, D. (2017). Effectiveness of simulation among undergraduate students in the critical care nursing. *International Archives of Nursing and Health Care*, 3(4), 1-8. <https://doi.org/10.23937/2469-5823/1510084>.
- Mould, J., White, H., & Gallagher, R. (2011). Evaluation of a critical care simulation series for undergraduate nursing students. *Contemporary Nurse*, 38(1-2), 180-190. <https://doi.org/10.5172/conu.2011.38.1-2.180>.
- Norman, G., Dore, K., & Grierson, L. (2012). The minimal relationship between simulation fidelity and transfer of learning. *Medical Education*, 46(7), 636-647.
- Pascual, J. L., Holena, D. N., Vella, M. A., Palmieri, J., Sicoutris, C., Selvan, B., ..., & Schwab, C. W. (2011). Short simulation training improves objective skills in established advanced practitioners managing emergencies on the ward and surgical intensive care unit. *The Journal of Trauma*, 71(2), 330-337. <https://doi.org/10.1097/TA.0b013e31821f4721>, discussion. 337-338.
- Steadman, R. H., Coates, W. C., Huang, Y. M., Matevosian, R., Larmon, R. B., McCullough, L., ..., & Ariel, D. (2006). Simulation-based training is superior to problem-based learning for the acquisition of critical assessment and management skills. *Critical Care Medicine*, 34(1), 151-157. <https://doi.org/10.1097/01.CCM.0000190619.42013.94>.
- Theilen, U., Leonard, P., Jones, P., Ardill, R., Weitz, J., Agrawal, D., ..., & Simpson, D. (2013). Regular in situ simulation training of paediatric medical emergency team improves hospital response to deteriorating patients. *Resuscitation*, 84(2), 218-222. <https://doi.org/10.1016/j.resuscitation.2012.06.027>.
- Urden, L. D., Stacy, K. M., & Lough, M. E. (2017). *Critical Care Nursing-E-Book: Diagnosis and Management*. USA: Elsevier.
- Weller, J. M., Nestel, D., Marshall, S. D., Brooks, P. M., & Conn, J. J. (2012). Simulation in clinical teaching and learning. *The Medical Journal of Australia*, 196(9), 594.
- Zarifanaiey, N., Amini, M., & Saadat, F. (2016). A comparison of educational strategies for the acquisition of nursing student's performance and critical thinking: Simulation-based training vs. integrated training (simulation and critical thinking strategies). *BMC Medical Education*, 16(1), 294. <https://doi.org/10.1186/s12909-016-0812-0>.