www.sciencedirect.com/journal/journal-of-vascular-nursing

Lecture-based education versus simulation in educating student nurses about central line–associated bloodstream infection–prevention guidelines

Sami M. Aloush, PhD, RN

The Center for Disease Control and Prevention published central line–associated bloodstream infection–prevention guidelines to prevent complications and improve the quality of care; however, it is not known whether student nurses receive education about these guidelines or what is the best approach to this education. This study aimed to assess student nurses' knowledge of central line–associated bloodstream infection–prevention guidelines and to compare the effectiveness of simulation versus classroom lecturing in educating them with these prevention guidelines. It used a two-arm randomized controlled trial design with pre-post tests. It was conducted at two public universities in Jordan, with a total of 131 fourth-year student nurses as participants. The participants were randomly assigned to the experimental group (receiving classroom lectures) and the control group (receiving a simulation course). Pretest and posttest data were collected using a structured questionnaire of 23 items. The overall knowledge scores in the pretest were poor with no statistically significant difference between the two groups. In the posttest, both groups showed improvement in the majority of items. The participants in the classroom lectures group scored slightly higher in the majority of items in the posttest; however, there was no statistically significant difference in the overall scores $t\ (129) = 1.03$, P = (.57), (95% confidence interval = −1.9 to 4.3). Focusing on the elements related to clinical skills and decision-making would help to make lecture-based education an effective alternative to simulation, especially in universities and nursing schools with limited budgets. (J Vasc Nurs 2018;37:125-131)

The central venous catheter is an invasive intravenous device commonly used in intensive care units (ICUs), widely indicated for intravenous fluid infusion, administration of medication, total parenteral nutrition, and measurement of central venous pressure. Unfortunately, its use is associated with several complications that are risky to patients and expensive to manage, including thrombosis, embolism, and central line–associated bloodstream infection (CLABSI).[1,2]

CLABSI is a laboratory-confirmed bacteremia detected 48 hours after insertion of the central venous catheter when there is no evidence of infection in other sites.[3] It is associated with an increase in the cost of care,[4,5] extended hospital stay,[6] and mortality.[7] One study reported that CLABSI increases the cost of care for each case by US$33,000 and extends the hospital stay by three weeks.[8] Many countries, especially in the modern world, have achieved a significant decrease in the rate of CLABSI, although 204,000 cases and 25,000 related deaths were reported in the United States in 2016.[9] Prevention of CLABSI and related complications is a major priority in clinical settings.

The Center for Disease Control and Prevention has published CLABSI-prevention guidelines, which help to reduce the rate of CLABSI and related complications.[10,11] The literature emphasizes the importance of multidisciplinary care and awareness of updated CLABSI-prevention guidelines and hygiene techniques through education of student nurses and other health professionals. Although evidence for the effectiveness of these guidelines is being compiled, studies have reported that nurses' current knowledge of the guidelines is poor.[12,13]

Nurses in clinical settings are required to demonstrate knowledge about the indications, complications, and maintenance of the central venous catheter.[14,15] Lack of knowledge may affect compliance in the future. Education is essential in the prevention of CLABSI. Arguably, the problem of nurses' poor knowledge is deeply rooted in education.

Traditionally, education about the central venous catheter involves classroom presentation and bedside observation during the clinical practicum. Videotapes and online discussion are usually used as inexpensive strategies to support the classroom

From the Al Al bayt University, School of Nursing, Mafraq, Jordan.

Corresponding author: Sami Aloush PhD, MSN, RN, Assistant Professor, Adult Health Nursing Department, Faculty of Nursing, Al albayt University, P.O. Box 130040, Mafraq, Jordan 25113 (E-mail: sma91@case.edu).

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

The author reports no conflicts of interest.

1062-0303/$36.00

https://doi.org/10.1016/j.jvn.2018.11.006

educational content. Recommendations for advancing nursing education in the CLABSI-prevention guidelines include the use of nontraditional approaches to stimulate students' learning.[16] Simulation emerged as an experiential teaching style in which students are placed in a scenario that is close to reality.[17,18]

Simulation has been used as an effective teaching strategy in nursing and other disciplines[19,20]; however, its use is limited because of technical and maintenance difficulties, the need for a more advanced technological infrastructure,[21] and higher cost, especially for high-fidelity simulation.[22,23] Simulation may therefore be too expensive, especially in developing countries with limited resources.[24,25]

Few studies have compared simulation with lecture-based education.[26] Simulation allows the student to experience challenges similar to real life without risking patients' lives; however, studies of its effectiveness in mitigating nurses' errors in real clinical settings are limited. The majority of studies on simulation evaluated students' performance in the laboratory but lacked objective evaluation of the simulated skills within the real clinical environment.[27] These limitations would make simulation education more time-consuming than classroom lectures. Although many studies reported the superiority of simulation over classroom lectures, they had several shortcomings that limited their value. These included the greater amount of time spent in simulation than in the classroom, so it was unclear if the improvement in students' performance in the simulation groups was related to the actual effect of the simulation or because of the longer training time they received.[27,28]

It is unclear if the use of a simulator would be more effective than lecture-based courses in improving knowledge and application of CLABSI-prevention guidelines. The purpose of this study was therefore to evaluate student nurses' knowledge of CLABSI-prevention guidelines and to compare the effectiveness of the two teaching strategies.

METHOD

The EBSCO, Medline, Cochrane Library, and CINAHL databases were searched for studies relevant to CLABSI, using the keywords CLABSI-prevention guidelines, evidence-based practice, simulation, and lectures. The search was limited to articles published from 2013 onwards.

Design

This study was a randomized controlled trial. Students were randomly assigned to either the experimental or the control group. Students in both groups completed pretest and posttest questionnaires. Those in the experimental group underwent a lecture-based educational course, whereas the control group experienced a simulation course.

Sample size estimation and participants

Eligible participants were fourth-year student nurses who had passed the critical care, infection-control, and medical surgical courses and had received clinical training during their course work.

The G* power 3.1[29] software was used to calculate the required sample size. Based on a power of 0.8, medium effect size of 0.5, and a level of significance of 0.05, the required sample size needed to run a two-group independent samples test was 128 participants, 64 in each group.

Study setting and sample

The study was conducted in two public universities in Jordan. A sample of 176 baccalaureate students were randomly selected, of whom only 136 agreed to participate. Students were assigned to either the experimental or the control group (68 students in each) using the Randomizer software.[30] Two sets of random numbers were generated. This software is available free online from the Social Psychology Network. Three students from the experimental group and two from the control group withdrew, leaving the final total at 131, 65 in the experimental group and 66 in the control group.

Instrument

A questionnaire was developed specifically for this study, based on the CLABSI-prevention guidelines from the Center for Disease Control and Prevention.[31] It has two parts, the first with demographic items and the second with 23 multiple-choice questions. Each of these questions had four options: 1) one correct answer, 2) two distractors, and 3) an "I don't know" choice. Each correct response was worth 1 mark, with no credit for the other responses. The highest score in the questionnaire was 23.

A pilot study with 10 participants was conducted to test the instrument and to detect any obstacles that might be encountered. An advertisement for the pilot study was distributed in the participating universities. Ten participants were selected based on the eligibility criteria for the major study, that is, fourth-year student nurses who had passed the critical care, infection-control, and medical surgical courses and had received clinical training during their course work. The selection of 10 participants was based on previous literature on the calculation of sample size for pilot studies.[32,33] The instrument was evaluated for clarity, understandability, internal consistency, reliability, and content validity by a panel of three infection-control specialists. SPSS[34] version 21 was used to calculate the internal consistency reliability of the instrument, indicating good internal consistency with a Cronbach alpha of 0.82. Some items were reworded upon recommendation of the panel. The panel also reviewed and validated the content of the two educational courses, recommending that an equal number of educational hours be given to the groups to prevent bias.

Ethical approval

The study was approved by the institutional review board of the participating universities. Students were instructed that their completion of the study questionnaire would be considered as consent to participate. To prevent potential coercion from the principal investigator in recruiting the participants and delivering the sessions, students were informed that participation was fully voluntary. They were informed that there was no direct benefit from participating in the study, but they were made aware that their participation will help in designing and improving nursing health science and patient care. Participants were allowed to withdraw from the study at any time with no penalties. Confidentiality was maintained throughout the whole study. A master code list with students' names and codes was compiled. Participants were instructed to use the codes as identifiers in the pretest and posttest. All materials related to the study were kept in the principal investigator's personal office with restricted access. All documents and data were discarded appropriately at the end of the study.

Data collection

Data were collected during November 2017. The study was advertised in the participating universities. Those interested in participating registered in the principal investigator's office and were randomly assigned to either the experimental or the control group. On the first day of the study, students in both groups completed the pretest questionnaire. All participants underwent the posttest after completion of the educational programs. The content of the educational courses was based on the Center for Disease Control and Prevention's CLABSI-prevention guidelines. The courses, questionnaire, pilot study, and major study were all completed during class time.

The classroom lectures course comprised three sessions of two hours each. The first session was a classroom lecture with a PowerPoint presentation, given by the principal investigator. The focus of the lecture was central venous catheter types, indications, insertion, complications, and nurses' role in the prevention of complications. Students were given hard copies of the PowerPoint slides at the end of the session. In the second session, a videotape was used to support the presentation. The videotape demonstrated correct application of the CLABSI-prevention guidelines, including handwashing, dressing, and manipulation of the central venous catheter system. In the third session, the focus was the updated CLABSI-prevention guidelines and their application in clinical settings.

The simulation group also received a course of three sessions of two hours each. The sessions took place in a simulation laboratory in the School of Nursing within the principal investigator's university. The laboratory has a maximum capacity of 20, so the students in the control group were separated into three groups of nearly 20 per group. The laboratory was equipped with the Laerdal IV Torso[35] critical care simulator, an advanced emergency and critical care simulator with intravenous accesses to the external and internal jugular veins, subclavian vein, and femoral vein. The torso is equipped with soft pads covered with realistic material, which simulates natural human skin. The simulated veins within the torso provide natural flashback of blood that looks like a real vein. The torso comes with a case to facilitate transportation. In the first session, the principal investigator explained the indications and complications of central venous catheters. The focus of the second was the central venous catheter care and CLABSI-prevention guidelines. The principal investigator demonstrated the CLABSI-prevention guidelines such as dressing, how to flush the system, and how to maintain sterility when access to the system is required. The third session was a role-play simulation session. Some students took the role of a nurse performing the prevention guidelines on the simulator, whereas the rest of acted as supervisors and gave feedback.

Data analysis

SPSS version 21 was used for data analysis. Data were first cleaned. Frequencies, mean, and standard deviation were used to describe the data. An independent sample *t*-test was used to test the difference in knowledge scores between the experimental and control groups. A paired-sample *t*-test evaluated the change in knowledge scores from the pretest to the posttest. The chi square test of association was conducted to investigate the association between the educational strategies—simulation versus lectures—and the students' answers in the posttest.

RESULTS

The study comprised a random sample of 131 baccalaureate student nurses. Of the 131 participants, 72 (55%) were female. The mean age was 21 years (standard deviation = 2.1). In the pretest, the majority (75%) reported that they had received some education about CLABSI prevention in school, whereas the remainder reported that they learned about CLABSI outside their schools through material from the media and other sources. The overall knowledge scores in the pretest were poor with no statistically significant difference between the two groups. Most participants were unaware that a transparent type of dressing has a lower risk of infection than a gauze dressing. Also, few participants knew that systematic prophylactic antibiotic has no value in reducing the risk of infection. In the posttest, both groups showed improvement in most items (Table 1). The participants in the simulation group scored slightly higher in the posttest; however, the difference was not statistically significant with t (129) = 1.03, P = (.57), (95% confidence interval = −1.9 to 4.3) (Table 2).

Post hoc analysis

There was a significant association between the educational strategy and the students' knowledge of routine change of the central venous catheter (χ^2 [1, N = 131] = 5.12, P = .02). There was also a significant association between the educational strategy and the knowledge regarding frequency of change for the intravenous fluid administration set (X^2 [1, N = 131] = 12.1, P = .00) and frequency of change for the total parenteral nutrition and blood administration set (X^2 [1, N = 131] = 5.7, P = .01). On the other hand, the lecture group scored higher in the items on the need for systematic prophylactic antibiotic to prevent CALBS (X^2 [1, N = 131] = 4.2, P = .00) and on the need for normal saline 0.9% routine flush (X^2 [1, N = 131] = 4.8, P = .00). There was no significant association between the educational strategy and the students' knowledge of the risk of infection according to the dressing material (transparent versus gauze) and no significant association with the hand-washing hygiene.

DISCUSSION

This study aimed to evaluate student nurses' knowledge of CLABSI-prevention guidelines and to compare the effectiveness of two educational courses on these guidelines: 1) simulation and 2) classroom lectures. In the pretest, significantly poor knowledge of CLABSI was observed in both groups. In the posttest, both groups demonstrated substantial improvement, although

TABLE 1

FREQUENCIES OF CORRECT ANSWERS IN THE PRE-POST TESTS (N = 131)

Recommended guideline for prevention of CLABSI	*Simulation pretest, n = 65*	*Lecture pretest, n = 66*	*Simulation posttest, n = 65*	*Lecture posttest, n = 66*
Routine change of the CVC	27 (42%)	29 (44%)	60 (92%)	43 (65%)
Change IVF set (fluid administration)	27 (42%)	29 (44%)	62 (95%)	41 (62%)
Change IVF set (TPN or blood)	28 (43%)	26 (39%)	59 (91%)	50 (75%)
Use a dedicated port for TPN administration	30 (46%)	28 (42%)	61 (94%)	60 (92%)
Change dressing (gauze and transparent dressing)	28 (43%)	22 (33%)	65 (100%)	61 (92%)
Frequency of handwashing (or alcohol hand rub)	46 (71%)	54 (81%)	60 (92%)	60 (92%)
Use of antibiotics-impregnated CVC	6 (9%)	10 (15%)	46 (71%)	45 (68%)
Risk of infection (transparent over the gauze)	3 (5%)	7 (11%)	55 (84%)	51 (77%)
Use 2% chlorhexidine with 70% alcohol solution to disinfect the catheter-insertion site and access port	12 (19%)	16 (24%)	60 (92%)	51 (77%)
Antibiotic ointment at the insertion site or access port	29 (45%)	31 (47%)	63 (97%)	45 (68%)
Full protective barriers for insertion (mask, gown, sterile gloves, full body drape, cap)	25 (39%)	25 (38%)	64 (98%)	63 (95%)
Subclavian insertion site	31 (48%)	37 (56%)	62 (95%)	60 (92%)
NS 0.9% routine flush	23 (36%)	29 (44%)	45 (69%)	63 (95%)
Systematic antibiotics	4 (6%)	18 (27%)	40 (61%)	60 (91%)
If oozing is noticed, the gauze dressing type is recommended over the transparent dressing	22 (34%)	36 (54%)	64 (98%)	55 (84%)
Removal of the CVC if there is no clinical indication	21 (32%)	23 (35%)	61 (94%)	50 (75%)
Antibiotics lock solution to sterilize lumen	19 (29%)	23 (35%)	60 (92%)	44 (67%)
Use CVC with single port over the multiple ports	4 (6%)	6 (9%)	59 (91%)	55 (83%)
Indication for tunneled CVC versus nontunneled CVC	14 (22%)	12 (18%)	60 (92%)	49 (74%)
Use no suture to secure the CVC	35 (54%)	43 (65%)	59 (91%)	51 (77%)
Assessment of CVC when fever develops	19 (29%)	37 (56%)	59 (91%)	44 (67%)
Use sterile gloves during insertion and dressing	9 (14%)	9 (14%)	62 (95%)	40 (60%)
Systematic anticoagulants	11 (15%)	16 (24%)	63 (97%)	55 (83%)

CLABSI = central line–associated bloodstream infection; CVC = central venous catheter; IVF = intravenous fluid; NS = normal saline; TPN = total parenteral nutrition.

TABLE 2

RESULTS OF THE PRE-POST KNOWLEDGE TESTS

Variable	*Number*	*Mean (SD)*	*t*	P	*95% CI*
Pretest					
Simulation	65	10.5 (3.3)	1.31	.19	−0.4 to 1.9
Lecture	66	9.8 (3.2)			
Posttest					
Within each group					
Simulation pretest	65	10.5 (3.3)	12.27	.00	
Simulation posttest	65	21.1 (1.4)			9.6 to 11.5
Lecture group pretest	66	9.8 (3.2)	11.62	.00	6.8 to 9.6
Lecture group posttest	66	19.3 (4.5)			

CI = confidence interval; SD = standard deviation.

there was no difference in the overall knowledge scores between the two groups.

Findings from this study revealed insufficient knowledge about CLABSI-prevention guidelines. In the pretest, significant weakness was noticed in topics related to the recommended antiseptic solution, the use of a single-port central venous catheter over a multiple-port one, the use of a tunneled versus a nontunneled catheter, sutureless versus suture securing, and the type of dressing material. These findings support those of previous studies.[36] For example, Mlinar and Rašković-Malnaršič[37] investigated student nurses' knowledge of central venous catheter care through a questionnaire to second-year students (N = 144). The study reported insufficient knowledge in several items.[37] The reason might be that baccalaureate students received insufficient clinical training or may have had no opportunity to attend ICUs during their clinical training, as most hospitals have policies limiting the number of students allowed in the ICU per shift. Observation in real life has a significant effect in registering and retrieving knowledge. Also, the overcrowded environment in the clinical settings might have affected students' learning. Collaboration between experienced health-care providers and student nurses would assist learning.[38,39] Other studies reported many challenges to the student nurses' learning experience, such as shortage of facilities, trainers, and clinical training sites.[40,41]

The findings from this study are consistent with those of Bodine and Miller[42] who compared two educational approaches to teaching a course on end-of-life care to emergency room nurses. One group received lectures, and the other received combined simulation and lectures. Both groups showed significant improvement in knowledge, but there was no significant difference between the two educational approaches after completion of the courses. Likewise, our findings are consistent with those of Sayedi, Sharififar, and Zareiyan[43] who reported no difference in knowledge scores among student nurses (N = 60) receiving simulation and lecture-based courses on biologic agents for treatment of hemorrhagic fever; both groups showed significant improvement in the posttest, but with no difference between them.

However, Cooper[44] compared the effectiveness of simulation versus lectures in educating student nurses (N = 98) in assessment and management of deteriorating patients and found that students in the simulation group achieved higher knowledge scores and reported greater satisfaction with the quality of education they received. A possible explanation for the difference between the findings from our work and other studies is that simulation has been reported as an effective strategy for decision-making and clinical skills, but not for increasing knowledge. Also, the relatively high number of students (20) in the simulation group sessions could have affected the results in our study, as it is known that simulation classes are not suitable for a large group of students.

Participants in the simulation group showed substantially more improvement in some items than did the lecture group, including the routine changing of the central venous catheter, the frequency of change for the intravenous fluid administration set, total parenteral nutrition, and blood administration set; however, their knowledge of hand hygiene was no different. The simulation group also scored higher for the items related to the need for normal saline 0.9% routine flush and for prophylactic systematic antibiotic to prevent CLABSIs. It is well known that simulation improves clinical skills rather than theoretical knowledge. Giving more focus on the elements that aim to improve students' decision-making in the clinical environment could further enhance the effectiveness of the classroom lectures.

The high cost of simulation may limit its use in settings with limited resources[45]; however, the benefits would justify its use in education.[46] Information on the economic evaluation of simulation is scarce. Evaluation of the cost-effectiveness of simulation versus classroom lectures would inform decision-makers about the best approach to education.[47]

Limitations

The present study has some limitations. First, participants in the simulation group scored significantly higher in several items; however, the study did not capture significant difference in the overall scores. Replication of this study with a larger sample size would help to confirm the findings. Second, although the study assessed the students' knowledge, it did not investigate the barriers and facilitators to learning in each group. Future studies are strongly encouraged to allow students to evaluate and criticize their learning experience. Third, the study included only Jordanian students, which might limit the generalizability of the findings. Future studies are recommended to include students of different nationalities. Fourth, the study was conducted during class time, and the effect of this timing on the findings was unknown. Future studies are recommended to investigate the effect of timing on the education outcomes. In addition, the large number of students in the simulation group sessions would have affected the findings. It is recommended to replicate this study with fewer students in the simulation group's sessions. Finally, the study did not assess the retention of knowledge after completion of the courses. Future study would benefit from measuring retention of knowledge, which would help in understanding the effectiveness of simulation and lectures in the improvement of registration and retrieval of knowledge.

CONCLUSION

Student nurses' knowledge about CLABSI-prevention guidelines was found to be poor. Both simulation and classroom lectures were effective in improving it. Students in the simulation group scored better in several items, although the overall difference between the groups was not significant. Substantial improvement in the simulation group over the lecture group was in the items related to clinical skills and decision-making. Application of lecture-based education in universities and nursing schools with limited budgets would be equally effective as an affordable teaching method. More focus on the topics that aim to improve students' clinical skills and decision-making would further enhance the effectiveness of classroom lectures.

REFERENCES

1. Pires RC, Rodrigues N, Machado J, et al. Central venous catheterization: an updated review of historical aspects, indications, techniques, and complications. Transl Surg 2017;2(3):66.
2. Linden AF, Corvin C, Garg K, et al. Indications and outcomes for tunneled central venous line placement via the axillary vein in children. Pediatr Surg Int 2017;33(9):1001-5.
3. Chaftari A-M, Jordan M, Hachem R, et al. A clinical practical approach to the surveillance definition of central line–associated bloodstream infection in cancer patients with mucosal barrier injury. Am J Infect Control 2016;44(8):931-4.
4. Shah HN, Schwartz JL, Luna G, et al. Bathing with 2% chlorhexidine gluconate: evidence and costs associated with central line–associated bloodstream infections. Crit Care Nurs Q 2016;39(1):42-50.
5. Harron K, Mok Q, Hughes D, et al. Generalisability and cost-impact of antibiotic-impregnated central venous catheters for reducing risk of bloodstream infection in paediatric intensive care units in England. PLoS One 2016;11(3):e0151348.
6. Brunelli SM, Turenne W, Sibbel S, et al. Clinical and economic burden of bloodstream infections in critical care patients with central venous catheters. J Crit Care 2016;35:69-74.
7. Harron K, Quen M, Dwan K, et al. Catheter infections in children (CATCH): a randomised controlled trial and economic evaluation comparing impregnated and standard central venous catheters in children (Chapter1). (Health Technology Assessment(No. 20.18.). Southampton (UK): NIHR Journals Library; 2016.
8. Harron K, Quen M, Dwan K, et al. CATheter Infections in CHildren (CATCH): a randomised controlled trial and economic evaluation comparing impregnated and standard central venous catheters in children (Chapter1). (Health Technology Assessment(No. 20.18.). Southampton (UK): NIHR Journals Library; 2016.
9. Bell T, O'Grady NP. Prevention of central line–associated bloodstream infections. Infect Dis Clin North Am 2017;31:551-9.
10. Ista E, van der Hoven B, Kornelisse RF, et al. Effectiveness of insertion and maintenance bundles to prevent central-line-associated bloodstream infections in critically ill patients of all ages: a systematic review and meta-analysis. Lancet Infect Dis 2016;16(6):724-34.
11. El Nemr WA, Fahmy HH, El Razek GMA, et al. An interventional study to decrease central venous catheter related blood stream infection in intensive care units at Zagazig University Hospital. Zagazig Univ Med J 2015;19(6):492-507.
12. Aloush S. Educating intensive care unit nurses to use central venous catheter infection prevention guidelines: effectiveness of an educational course. J Res Nurs 2018;23(5):406-13.
13. Sharour LA. Oncology nurses' knowledge about central line catheter: caring, complications, and applications among cancer patients—A cross-sectional study. J Vasc Nurs 2018;36:145-8.
14. Esposito MR, Guillari A, Angelillo IF. Knowledge, attitudes, and practice on the prevention of central line-associated bloodstream infections among nurses in oncological care: a cross-sectional study in an area of southern Italy. PLoS One 2017;12(6):e0180473.
15. Kim M-H, Heo J. Study on central line bundle cognition, knowledge and performance level of infection management on central venous catheter among intensive care nurses. Korean J Healthc Ass Infect Control Prevent 2017;22(1):21-30.
16. Kelly LJ, Green A, Hainey K. Implementing a new teaching and learning strategy for CVAD care. Br J Nurs 2015;24(8):S4-8.
17. Dubovi I, Levy ST, Dagan E. Now I know how! The learning process of medication administration among nursing students with non-immersive desktop virtual reality simulation. Comput Educ 2017;113:16-27.
18. Cant RP, Cooper SJ. Use of simulation-based learning in undergraduate nurse education: An umbrella systematic review. Nurse Educ Today 2017;49:63-71.
19. Padilha JM, Machado PP, Ribeiro AL, et al. Clinical virtual simulation in nursing education. Clin Simul Nurs 2018;15:13-8.

20. Jarvill M, Jenkins S, Akman O, et al. Effect of simulation on nursing students' medication administration competence. Clin Simul Nurs 2018;14:3-7.
21. Maskálová E, Urbanová E, Bašková M, et al. Experience of lecturers with simulation training in midwifery education in Slovakia. Midwifery 2018;59:1-3.
22. Krishnan DG, Keloth AV, Ubedulla S. Pros and cons of simulation in medical education: a review. Education 2017;3(6):84-7.
23. Maloney S, Haines T. Issues of cost-benefit and cost-effectiveness for simulation in health professions education. Adv Simul (Lond) 2016;13(1):1-6.
24. Kim H. Experience of simulation-based training in a developing country. Simul Healthc 2017;12(3):202.
25. Abass OA, Samuel BO, Odufeko GT. Medical simulation a tool yet untapped in most developing nations in Africa. Int J Comput Appl 2014;97(5):1-4.
26. Maddry JK, Varney SM, Sessions D, et al. A comparison of simulation-based education versus lecture-based instruction for toxicology training in emergency medicine residents. J Med Toxicol 2014;10(4):364-8.
27. Cook DA, Hatala R, Brydges R, et al. Technology-enhanced simulation for health professions education: a systematic review and meta-analysis. JAMA 2011;306(9):978-88.
28. Lam G, Ayas NT, Griesdale DE, et al. Medical simulation in respiratory and critical care medicine. Lung 2010;188(6):445-57.
29. Erdfelder E, Faul F, Buchner A. GPOWER: a general power analysis program. Behav Res Methods Instrum Comput 1996;28(1):1-11.
30. Research randomizer (computer software Geoffrey C. Urbaniak and Scott Plous) [computer program]. Lancaster: Pennsylvania; 2015.
31. Marschall J, Mermel LA, Fakih M, et al. Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol 2014;35(S2):S89-107.
32. Isaac S, Michael WB. Handbook in research and evaluation. San Diego, USA: Wiley Periodicals, Inc., A Wiley Company; 1981.
33. Hill R. What sample size is "enough" in internet survey research. Interpersonal Comput Technol 1998;6(3-4):1-10.
34. Statistical package for the social sciences (SPSS) [computer program]. Armonk, NY: IBM; 2012.
35. LaerdalR IV Torso. USA: Laerdal Medical; 2018.
36. Jiang J, Zeng L, Kue J, et al. Effective teaching behaviors in the emergency department: a qualitative study with Millennial nursing students in Shanghai. Nurse Educ Today 2018; 61:220-4.
37. Mlinar S, Rašković-Malnaršić R. Knowledge of nursing students about central venous catheters. Vojnosanit Pregl 2012; 69(4):333-9.
38. Mikkonen K, Pitkäjärvi M, Kääriäinen M. International healthcare students in clinical learning environments. Professional learning in the work place for international students. Switzerland: Springer; 2017:147-63.
39. Wong AKC, Wong FKY, Chan LK, et al. The effect of interprofessional team-based learning among nursing students: a quasi-experimental study. Nurse Educ Today 2017;53:13-8.
40. Robinson BK, Dearmon V. Evidence-based nursing education: Effective use of instructional design and simulated learning environments to enhance knowledge transfer in undergraduate nursing students. J Prof Nurs 2013;29(4):203-9.
41. Arkan B, Ordin Y, Yılmaz D. Undergraduate nursing students' experience related to their clinical learning environment and factors affecting to their clinical learning process. Nurse Educ Pract 2018;29:127-32.
42. Bodine JL, Miller S. A comparison of lecture versus lecture plus simulation: educational approaches for the end-of-life nursing education consortium course. J Hosp Palliat Nurs 2017;19(1):34-40.
43. Seyedi R, Sharififar S, Zareiyan A. Comparison of the effect of lecture and simulation teaching methods on nursing students knowledge, in personal protection against biological agents of viral hemorrhagic fevers. Mil Car Sci 2017;3(4): 220-31.
44. Cooper S. Simulation versus lecture? Measuring educational impact: considerations for best practice. Evid Based Nurs 2015;19(2):55.
45. Bearman M, O'Brien R, Anthony A, et al. Learning surgical communication, leadership and teamwork through simulation. J Surg Educ 2012;69(2):201-7.
46. Maloney S, Haines T. Issues of cost-benefit and cost-effectiveness for simulation in health professions education. Adv Simul (Lond) 2016;1(13):1-6.
47. Zendejas B, Wang AT, Brydges R, et al. Cost: the missing outcome in simulation-based medical education research: a systematic review. Surgery 2013;153(2):160-76.