

Effect of Simulation-Based Education on Nurses' Performance and Satisfaction regarding Peripherally Inserted Central Catheters at Neonatal Intensive Care Unit Sabra Mohamed Ahmed¹, Hanan Abdallah Mohammed², Manal Mohamed Ahmed Ayed³, Fathia El-Sayed El-Ghadban⁴, Fatma Mohamed Amin⁵

¹ Lecturer, Pediatric Nursing, Faculty of Nursing, Sohag University

² Lecturer, Pediatric Nursing, Faculty of Nursing, Fayoum University

³ Assistant Professor, Pediatric Nursing, Faculty of Nursing, Sohag University

⁴ Assistant Professor, Pediatric Nursing, Faculty of Nursing, Fayoum University

⁵ Assistant Professor, Pediatric Nursing, Faculty of Nursing, Mansoura University, Egypt

Abstract

Background: Peripherally inserted central catheter is an essential device used frequently in neonatal intensive care units for critically ill neonates who need continuous monitoring and resuscitation treatments. Simulation-based education serves as a link between classroom learning and clinical practice. It aids nursing competency before working with neonates in a real-life environment, hence improving the quality of care and ensuring neonates' safety. **This study aimed to:** evaluate the effect of simulation-based education on nurses' performance and satisfaction regarding peripherally inserted central catheters in the Neonatal Intensive Care Unit. **Subject and Method: Design:** A quasi-experimental research design was used. **Setting:** The study was conducted in the Neonatal Intensive Care Unit affiliated to Sohag University Hospital. **Subjects:** all nurses (50) who are working in the neonatal intensive care unit. **Tools for data collection:** (1) peripherally inserted central catheter questionnaire sheet, (2) observational checklist, and (3) nurses' satisfaction scale was used to collect data. **Results:** There was a highly statistically significant difference between the studied nurses' knowledge, practice, and satisfaction. The study result revealed that more than two-thirds of studied nurses had a poor level of knowledge, and more than half of them had an unsatisfactory level of practice about peripherally inserted central catheters before implementation of the simulation-based education. The vast majority of the studied nurses had a good level of knowledge and most of them had a satisfactory level of practice after implementing simulation-based education. There was a highly statistically significant difference and improvement in nurses' performance after simulation-based education than pre-education. **Conclusion:** The present study concluded that simulation-based education had a positive effect on improving nurses' performance and satisfaction regarding peripherally inserted central catheters. **Recommendations:** The study recommended that simulation-based education should be integrated as an effective method in nurses' training about peripherally inserted central catheters.

Keywords: Nurses' Performance, Peripherally Inserted Central Catheters, Satisfaction, Simulation-based education.

Introduction

The peripherally inserted central catheter (PICC) is an intravenous device that is placed into the central veins through the peripheral veins and is often used for long-

term intravenous therapy, blood and nutrition administration, and frequent blood samples. ⁽¹⁾

Peripherally inserted central catheters (PICCs) are an integral component

frequently used in neonatal intensive care units (NICUs) for critically ill neonates, which usually have hemodynamic instability and need for continuous monitoring and resuscitation treatment. PICCs are vitally important to optimize the management of neonates admitted to NICU, in particular, preterm and critically ill neonates. One method of accomplishing sufficient nutrition, hydration, and medical support is using PICCs. ⁽²⁾

The peripherally inserted central catheter is an advanced procedure that is a type of central venous access device (CVAD). The most common insertion site is above the antecubital area using the median, cephalic, or basilic vein. The catheter is threaded either with or without a guidewire into the superior vena cava. ⁽²⁾ The use of ultrasound guidance for placement of PICCs has become the gold standard for verification before use. ⁽³⁾

The peripherally inserted central catheter has become one of the most widely used techniques in NICUs. It is an essential lifesaving intervention, taking into account that neonatal co-morbidity and mortality have a direct effect on critically ill neonates. ⁽⁴⁾ Peripherally central catheters were originally designed to deliver parenteral nutrition, but their applications have expanded to include chemotherapy, antibiotic treatment, long-term dehydration, and frequent blood sampling. ⁽⁵⁾ It has the advantage of reducing the common side effects of short peripheral catheters, such as thrombosis, obstruction, and leakage, insertions can be performed within the hospital ward and provide safe infusions of drugs with high osmolality or with non-physiological acidity. The PICCs are also cost-effective and provide long-

term intravascular access, comfort, and a smooth transition to home care. ^(5,6)

The choice of peripherally inserted central catheter device should be based on the evaluation of the clinical condition of the neonates and the therapeutic goals. ⁽⁷⁾ Although PICCs are generally considered safe devices, they are associated with numerous complications such as an increased risk of sepsis, central line-associated bloodstream infection (CLABSI), thrombosis, embolism, or other complications that ultimately due to an increased length of hospitalization and hospital costs. ⁽⁸⁾ Approximately 30% of PICC failed before the accomplishment of treatment because of complications that would delay drug administration and blood sampling. Therefore, it necessitates professionals to master the technical procedure in addition to knowing such procedure. ⁽⁹⁾

Simulation-based clinical education in nursing refers to a variety of activities using pediatric patient simulators, involving devices, trained professionals, lifelike virtual environments, and role-playing, not just handling mannequins. Clinical simulation-defined by the National Council of State Boards of Nursing (NCSBN) as "an activity or event replicating clinical practice using scenarios, high-fidelity manikins, medium-fidelity manikins, standardized patients, role-playing, skills stations, and computer-based critical thinking simulations" has become an essential part of nursing education. ⁽¹⁰⁾

Simulation-based clinical education help to provide rapid feedback, repetitive practice learning, the option to change the difficulty

level, and the possibility to individualize learning are all advantages of simulation-based educational interventions. ⁽¹¹⁾ However, according to the research, opportunities to perform nursing techniques on live patients are typically limited during undergraduate degrees. ⁽¹²⁾ This reality may have an impact on the development of future newly trained healthcare workers' competence, increasing the likelihood of errors and jeopardizing patient safety. ^(13,14)

Nursing satisfaction is an integral element for evaluating their motivation, gratification, and acceptance of teaching strategy. It is the degree to which the learner can give extreme service with a positive attitude, continue patient-centered, and prove teamwork skills in multidimensional health care settings. ^(15,16)

The role of the nurse in the neonatal peripherally inserted central catheter is critical which is starting before PICCs including neonatal assessment and preparation of neonates. During PICCs it involves sterile dressing changes per agency schedule and protocol, flushing to maintain patency, and careful observation for any complications. Pediatric nurses must use protocols and practice the best evidence-based strategies for the insertion and maintenance of PICCs to prevent these complications ⁽⁹⁾. Measures for maintenance of asepsis are other important considerations that must not overlook also the nurses have to post PICCs duties including assessment and documentation which will also improve the standard of care and improve neonates' outcomes. ⁽¹⁷⁾

Different evidence has been showing that; nurses often perform procedures traditionally or routinely, which indicates

the existence of a gap between scientific knowledge and common practice. Furthermore, the procedure can cause harm to the neonates if it is done incompletely, therefore pediatric nurses must have knowledge and skills based on valid scientific evidence in performing PICCs care. ⁽¹⁸⁾

Significance of the study

The improper technique of PICCs care at NICU leads to various complications in critically ill neonates such as occlusion, infection, leakage, phlebitis, displacement, pleural effusion, and breaks, which affect the neonates' prognosis, length of hospitalization, and costs. ⁽¹⁸⁾

In addition, there has been much growth in understanding PICC practices and outcomes in adults; less has been learned in pediatric and neonatal populations. This leaves knowledge gaps regarding practice for neonates who are the smallest and most vulnerable. ⁽¹⁹⁾ So, this study focused on improving the nurses' knowledge, practice and satisfaction through implementing the simulation-based education regarding PICCs at NICU.

Aim of the study

To evaluate the effect of simulation-based education on nurses' performance and satisfaction regarding PICCs at NICU.

Research Hypotheses:

Simulation-based education is expected to have a positive effect on improving nurses' knowledge, practice, and satisfaction regarding PICCs at NICU.

Subject and methods

Research design:

A quasi-experimental design (one group pre/ post-test design) was used.

Settings:

The study was carried out at NICU at Sohag University Hospital.

Subjects:

All nurses (50) who are working in the previously mentioned setting during the study period and caring for premature neonates regardless of their age, education, or years of experience.

Tools for data collection:

Three tools were used for collecting data in this study.

Tool (I): Peripherally inserted central catheter questionnaire: It was developed by the researchers after reviewing the national and international related literature. ^(9,19). This tool consisted of two parts as the following:

Part 1: This part included data about nurses' demographic characteristics such as nurses' age, gender, education, and years of experience.

Part (2): Structured multiple-choice questionnaire (pre, immediate post and after two months) to assess the nurses' knowledge about the PICCs for neonates. It involved:

1. Definition of the PICCs, purpose, indications, most common insertion sites, and complications (10 questions).
2. Preparation and assessment prior PICCs (5 questions).
3. Role of the nurse regarding the care of PICCs (10 questions).
4. Role of the nurse to prevent the complications of PICCs (5 questions).

Scorings system:

Each correct answer was given a score of one and the incorrect answer received a score of (zero). The nurses' knowledge level was categorized as follows: poor less

than 50%, fair ranging from 50-75%, and good more than 75%⁽²⁰⁾.

Tool II: Peripherally central catheter observational checklist (pre/posttest). This tool was adapted from ^(18,19). The observation checklist was used to assess nurses' practice regarding PICCs in the area of assessment and preparation of neonates including 6 items, dressing change 13 items, flushing PICC 10 items, and IV fluids and medications 11 items

Scoring system:

The Observational checklist's scoring system was as follows: correctly completed scored (2), incompletely completed scored (1), and not completed scored (0). According to Alfar et al. (2020) ⁽²¹⁾, total nursing practices were classified into two categories: satisfactory and unsatisfactory practice. If the nurse's score was less than 80%, it was unsatisfactory practice and if the nurse's score was more than 80%, it was considered satisfactory practice

Tool III: Nurses' satisfaction scale: Nurses' satisfaction with the simulation experience was assessed using a scale developed by the National League for nursing. ⁽²²⁾ It comprised of five items and was created to assess the satisfaction of nurses with the simulation activity. A 5-point Likert scale was used to grade each item. Strongly disagree received a score of 1, disagree received a score of 2, undecided received a score of 3, agree received a score of 4, and strongly agree received a score of 5. The total score varied from 5 to 25, with the greater the score, the higher the level of satisfaction. It included questions about whether. The teaching methods used in the Simulation were effective, simulation provided a

variety of learning materials and activities to promote my learning, whether I enjoyed being taught by simulation, and whether The teaching material used in the simulation was motivating, and the way the simulation was suitable to be learned.

Scoring System:

The nurses' satisfaction level was classified as follows: unsatisfactory if the score is less than 80%, but it is considered satisfactory if the score is 80% or over.

Method

Validity and reliability:

Content validity was assessed by five experts in the pediatric nursing field who revised the tools for clarity, relevance, applicability, and extensiveness. Regarding the reliability of internal consistency by using Cronbach's alpha coefficient test was as follow; tool (I) was 0.942, for tool, II was 0.892 and tool III was 0.94.

Ethical considerations:

Official permission was obtained through an issued letter from the Dean of the Faculty of Nursing, Sohag University. The researchers met the administrators of the NICU to illuminate the purpose of the study and get their agreement and collaboration for conducting this study.

Informed consent was attained from nurses to share in this study after an explanation of the aim and benefits of the current study. The researchers informed the studied nurses that, they had the right to withdraw from the study at any time. Furthermore, they were assured that their information would be confidential.

Pilot study:

The pilot study was carried out. It involved ten percent of the total sample (5 nurses) to test the simplicity, feasibility,

clarity, and applicability of the developed tools, and the necessary modifications were done. The pilot study was excluded from the total sample of the study.

Field of work:

Approval was obtained from the director of Sohag University Hospital. The study was conducted within the period from the beginning of April 2021 to the end of September 2021. At the beginning of the interview, the researchers greeted each nurse, introduced themselves, and explained the aim and nature of the study.

Phases of the study: The study was conducted through the following four phases:

I-Assessment Phase

- Every nurse was interviewed pre conducting the program to collect the nurses' characteristics utilizing tool (I) part (1).
- Nurses' knowledge, practice, and satisfaction regarding PICCs were assessed through utilizing tool (I) part (2), tool II and tool III.

II. Planning phase:

The objectives, priorities, and predictable outcomes were articulated depending on the findings of the previous phase, to meet the nurses' practical needs, knowledge deficits, and satisfaction related to neonate PICCs. Five sessions (2 theoretical and 3 practical) were planned by the researchers for the studied nurses.

The educational program:

An educational program was designed and revised. It included theoretical and practical sessions regarding PICCs.

The general objective of simulation-based education sessions:

At the end of the sessions, the nurses were expected to acquire knowledge and

practices that improve their performance and satisfaction with PICCs in NICU

Specific objectives of the program:

- Define PICCs.
- Identify the purpose of PICCs.
- Enumerate the indication of the PICCs.
- List the most common sites of the PICC.
- Demonstrate the care of the PICCs.
- Identify the most common complications of PICCs.
- Perform the appropriate documentation.

III. Implementation phase:

- The implementation of simulation-based education was aimed to improve nurses' performance and satisfaction regarding PICCs at NICUs through five sessions: two theoretical and three practical sessions (around 30-45 minutes for each).
- At the beginning of each session, the researchers started by taking feedback about the previous session and at the end of each session the researchers, give a summary.
- The researchers were available in the study settings 3 days per week from 9 a.m. to 1 p.m. Each nurse was individually interviewed using the previously mentioned study tools.
- The studied nurses were classified into subgroups, with varying numbers (6-8 nurses in each group).
- The simplified booklet was used as supportive material and given to nurses in the Arabic language to cover all items regarding the knowledge and practice regarding PICCs after reviewing the associated literature based on the assessment of the actual needs of the studied nurses.
- Different teaching methods such as

lectures, small group discussion, pictures, brainstorming, demonstration, re-demonstration using the necessary equipment and using simulation manikin that was available in in a hospital teaching class faculty clinical lab to apply for simulated education program. Several teaching media were used, such as handouts, PowerPoint, figures, flipchart, and illustrated videos were used about PICCs.

The theoretical and practical sessions were carried out as the following

The first session (Theoretical): At the beginning of this session, the researchers introduced themselves, welcomed the nurses, show gratitude for their sharing in the study, and explained the objectives of these educational sessions. The 1st session covered the following items: definition purpose, indications, the most common insertion sites, and complications of the PICCs.

Second session (Theoretical): these sessions covered the items related to the role of the nurse regarding the care of PICCs, and the role of the nurse to prevent the complications of PICCs.

Third session (Practical): these sessions included training the studied nurses on the preparation and assessment of neonates prior PICCs.

Fourth session (Practical): these sessions included clinical demonstration and re-demonstration of studied nurses on the PICCs procedure that were conducted at the faculty clinical lab. These sessions were carried out using the simulation manikin. After the faculty lab sessions, trainees transferred to the neonatal intensive care of Sohag University Hospitals to provide them with real-time

re-demonstration under the supervision of the researchers to provide them trust and confirm competence in implementing the procedures for their neonates.

Fifth session (Practical): Started by taking feedback about the previous sessions, and answering any questions related to PICCs, the researcher distributed the post-test, then thanked all the participant's nurses for their sharing in the study.

IV-Evaluation phase:

Nurses' performance and satisfaction were reassessed immediately after the implementation of the simulated-based education program (posttest) using the previously mentioned tools and two months later (follow-up) to evaluate the effect of the simulated-based education program.

Statistical analysis:

- Data were tabulated, coded, and translated into a specially designed form that could be entered into a computer. SPSS version 22 was used to enter and evaluate the data. The graphics were created with the help of the Excel application. For comparison of the same group on the pretest and posttest, quantitative data were reported as mean and SD and evaluated using a t-test. Numbers and percentages were used to represent quantitative data. The relationship between normally distributed quantitative variables was explained using Pearson correlation. The significance was determined using a P-value of 0.05 as follows:
 - A P-value less than 0.05 was considered to be statistically significant.
 - A P-value less than or equal to 0.001 was considered to be highly statistically significant.

Results

Table (1): Shows that (60%) of the studied nurses were aged < 25 years with a mean of 25.8 ± 4.7 years, and 74% of them were females. Concerning qualifications of the studied nurses (68%) of them were Technical Institute of nursing and 32% were Baccalaureate degree of nursing. Regarding years of experience, 46% of them had experience from 5 – <10 years, and (30%) had experience < 5 years.

Table (2): Illustrates an improvement with a highly statistically significant difference found between nurses' knowledge pre/ immediately post, and two months post-simulated-based education implementation ($P < 0.001$).

Table (3): Demonstrates that 66% of nurses had a poor knowledge level about the procedures before receiving the simulated-based education. But after receiving simulated-based education, their level of knowledge improved to a good level (90.0%) and two months post-simulated-based education implementation (92.0%). A highly significant difference was detected between nurses' knowledge level pre/immediate post, and two months post-simulated-based education implementation ($P < 0.001$).

Table (4): demonstrates that there was a highly statistically significant difference before, immediately after post, and two months after simulated-based education implementation. It was clear from this table that 48% of the studied nurses had an unsatisfactory level of practice regarding assessment and preparation prior PICCs before the program, compared to 100% and 94% respectively immediately after post and two months post-simulated based education implementation had a satisfactory level of practice. Also, it was

found that 66% of studied nurses had an unsatisfactory level of practice regarding flushing before the program, compared to 96% immediately after the program and 88% two months post-simulated based education implementation had a satisfactory level of practice.

Figure (1): Portrayed the distribution of the studied nurses’ practice level related PICCs procedure pre, immediately post, and two months post- simulated based education implementation and indicated that (90%) of the studied nurses had an unsatisfactory practice level pre- simulated based education implementation compared to 10% post-education, while 89% of them had a satisfactory practice level post- two months of simulated based education implementation.

Table (5): Demonstrates the distribution of the nurse's satisfaction level at two months post- simulated based education implementation related to the procedures after simulation-based education, while, a

Table (1): Percentage distribution of the studied nurses regarding their demographic characteristics (n = 50)

Demographic characteristics	No	%
Age (Years)		
< 25 years	30	60
25 - ≥ 36 years	20	40
Mean ± SD	25.8 ± 4.7	
Gender:		
Male	13	26
Female	37	74
Qualifications:		
Technical Institute of nursing	34	68
Baccalaureate degree in nursing	16	32
Years of experience:		
< 5 years	15	30
5 – <10 years	23	46
10 - ≥15 years	12	24

higher percentage of them reported a satisfactory level, post receiving the simulated based education, and at two months post- simulated based education implementation.

Table (6): Showed that there was a positive correlation between nurses' knowledge, practice, and their satisfaction post receiving the simulated-based education regarding PICC procedure at a p-value $p < 0.001$. Correlation revealed significant positive correlations between knowledge- practice ($r = 0.447, p < 0.001$), knowledge- satisfaction ($r = 0.223, p < 0.001$), and practice - satisfaction ($r = 0.222, p < 0.001$). This result confirms the positive relationship between knowledge, practice, and satisfaction among the studied nurses regarding PICC procedure.

Table (2): Percentage distribution of the studied nurses' knowledge regarding peripherally inserted central catheters pre, immediately post, and two months post- simulated based education implementation (n =50)

Nurses' knowledge regarding peripherally inserted central catheters	Pre-simulated based education implementation		Immediately Post- simulated based education implementation		Two months Post- simulated based education implementation		F	P-value
	No	%	No	%	No	%		
Definition								
- Correct	30	60.0	50	100	50	100	112.5	<0.001**
- Incorrect	20	40.0	0	0.0	0	0.0		
Indications								
- Correct	24	48.0	49	98.0	46	92.0	132.6	<0.001**
- Incorrect	26	52.0	1	2.0	4	8.0		
Insertion sites								
- Correct	26	52.0	47	94.0	45	90.0	122.8	<0.001**
- Incorrect	24	48.0	3	6.0	5	10.0		
Preparation and assessment								
- Correct	22	44.0	46	96.0	47.0	94	107.4	<0.001**
- Incorrect	28	56.0	4	4.0	3.0	6.0		
Role of the nurse during insertion								
- Correct	19	38.0	46	96	46	92.0	97.9	<0.001**
- Incorrect	31	62.0	4	4.0	4	8.0		
The role of the nurse is to prevent complications								
- Correct	28	56.0	49	98.0	47	94.0	87.6	<0.001**
- Incorrect	22	44.0	1	2.0	3	6.0		

(**) highly statistical significance at $p < 0.001$

Table (3): Percentage distribution of the studied nurses' level of knowledge regarding peripherally inserted central catheters procedure pre, immediately post, and two months post simulated based education implementation (n=50)

Nurses' knowledge level	Poor		Average		Good		F	P-value
	No.	%	No	%	No	%		
Pre-simulated based education implementation	33	66.0	15	30.0	2	4.0	127.7	0.000**
Immediately post educational knowledge	0	0.0	5	10.0	45	90.0		
Two months Post- simulated based education implementation	0	0.0	4	8.0	46	92.0		

(**) Highly significant at $P < 0.001$

Table (4): Percentage distribution of the total nurses' practice regarding peripherally inserted central catheters pre, post, and two months post simulated based education implementation (n=50)

Nurses' practice	Pre-simulated based education implementation				Immediately Post- simulated based education implementation				Two months Post-simulated based education implementation				F	P
	Unsatisfactory		Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory		Satisfactory			
	No	%	No	%	No	%	No	%	No	%	No	%		
Assessment and preparation	24	48.0	26	52.0	0	0	50	100	3	6.0	47	94.0	117.2	0.000**
Dressing change	27	54.0	23	46.0	5	10.0	45	90.00	4	8.0	46	92.0	183.2	0.000**
Flushing	33	66.0	17	34.0	2	4.0	48	96.0	6	12.0	44	88.0	123.36	0.000**
IV fluids and medications	34	68.0	16	32.0	3	6.0	47	94.0	7	14.0	43	86.0	83.31	0.000**

(**) Highly significant at P<0.001

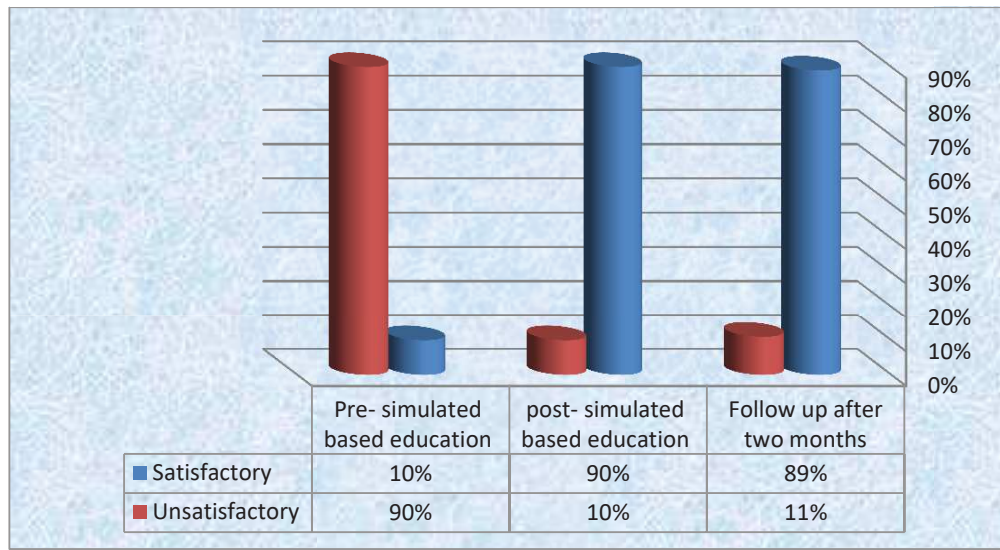


Figure (1): Distribution of the studied nurses' practice regarding peripherally inserted central catheters pre, immediately, and post- simulated based on education implementation

Table (5): Percentage distribution of nurses' satisfaction level immediately and after Two months Post-simulated based education implementation (no=50)

Satisfaction items	Post-simulation-based education				Two months Post-simulated based education implementation				F	P
	Unsatisfactory		Satisfactory		Unsatisfactory		Satisfactory			
	No	%	No	%	No	%	No	%		
The teaching methods used in the Simulation were effective	2	4%	48	96%	1	2%		98%	354.1	0.000**
Simulation provides a variety of learning materials and activities to promote my learning	1	2%	49	98%	1	2%	49	98%	629.1	0.000**
I enjoyed being taught by simulation	2	4%	48	96%	3	6%	47	94%	354.1	0.000**
The teaching material used in the simulation was motivating	3	6%	47	94%	4	8%	46	92%	590.4	0.000**
The way the simulation was applied was suitable to be learned	1	2%	49	98%	2	4%	46	96%	629.1	0.000**

(**) Highly significant at P<0.001

Table (6): Correlation coefficient between total knowledge, practice, and satisfaction among the studied nurses pre and post-two months of simulated based education implementation (No= 50)

Variable	Correlation coefficient	P-value*
Knowledge- satisfaction	0.447	<0.001**
Knowledge- practice	0.223	<0.001**
Satisfaction - practice	0.222	<0.001**

(**) Correlation is highly significant at the <0.001

Discussion

Neonates receive feeding and long-term drugs through peripherally inserted central catheters at (NICUs) **Sharpe et al. (2017)** ⁽²³⁾. The need for peripherally implanted central catheters to give parenteral nourishment, intravenous fluids, and drugs is growing as an increasing number of very low birth weight and critically unwell newborns survive **Chopra et al. (2016)** ⁽²⁴⁾. As a result, nurses are always challenged to enhance the means via which they offer safe and consistent vascular access to neonates at risk **Nobre et al. (2016)** ⁽²⁵⁾.

Simulation is one of the techniques that nursing educators can use to help future nurses prepare for real-world practice. The achievement of a specific work as judged against known standards of accuracy, completeness, cost, and speed is referred to as performance. An increasing body of research suggests that insufficient nurse knowledge preparation and poor skill are linked to poor outcomes, particularly in the critically sick newborn **McGaghie et al.**

(2019) ⁽²⁶⁾. Hence, this study aims to evaluate the effect of simulation-based education on nurses' performance and satisfaction regarding PICCs in NICU.

According to the findings of this study, three-fifths of the nurses were under the age of 25, with the majority of nurses being female. This finding is consistent with **Se and LS (2016)** ⁽²⁷⁾, who found that nurses aged 21-26 years in their study about "Nurses' knowledge and performance concerning peripheral intravenous catheter care." Also, in a study titled "Nurses' information regarding peripheral central catheter nursing care and its impacts on keeping it patent, China: a cross-sectional survey," **Xu et al. (2020)** ⁽²⁸⁾ discovered that the average age group was 25 years.

Concerning the educational level of nurses, the current findings revealed that more than two-thirds of the nurses had a technical nursing education. These results contradicted **Se and LS (2016)** ⁽²⁷⁾ who found that most of the participants possessed a Diploma in Nursing. Similarly,

Deshnukh and Shinde (2014) ⁽²⁹⁾ conducted a study in India called "Impact of structured education on knowledge and practice regarding venous access device care among nurses," and found that the majority of the participants were between the ages of 21 and 30 years and that the majority of them were females. The findings of the current study could be clarified by the fact that nursing was formerly solely available to girls in Egyptian institutions until a few years ago; this fact may explain the high number of females.

As regards years of experience, it was found that less than half of the studied nurses had more than 5 and less than 10 years of working in the NICU. The result was contradicted by **Deshnukh and Shinde (2014)** ⁽²⁹⁾ who found that most of the participants 71.67 % had less than 5 years of clinical experience. Similarly, a study titled "Evaluation of nurse's knowledge in the management of premature baby in neonatal units," by **Issa et al. (2018)** ⁽⁶⁾ discovered that nearly one-third of the nurses investigated had one to five years of experience. Furthermore, **Mohammed and Abdel Fattah (2018)** ⁽³⁰⁾ found that more than half of the participants had between one and five years of experience.

According to total nurses' knowledge level about PICC pre/ immediately post , and two months post- simulated based education implementation, the present results discovered that more than two-thirds of the studied nurses had a poor level of knowledge about the PICC before receiving the simulated based education while after the program vast majority of them their level of knowledge improved to

a good level and two months post simulated based education program with a highly statistically significant difference between nurses' knowledge level pre/immediate post, and two months post-simulated based education implementation. From the researchers' point of view, this demonstrates how well the simulated-based education implementation was very effective. This reflected the imperative need to understand the purpose of the simulated-based education implementation to improve knowledge. This result is supported by **Cerra et al. (2018)** ⁽³¹⁾ who studied "Effects of high-fidelity simulation-based on life-threatening clinical condition scenarios on learning outcomes of undergraduate and postgraduate nursing students" and stated that simulation training had positive effects on nursing students' knowledge and performance.

In addition, the result is matched with **Kun, et al. (2017)** ⁽³²⁾, who found an improvement in knowledge, attitude, and skills on PICC before training was very low, indicating that the nurses did not have enough knowledge about PICC pre training, which significantly improved post intervention, indicating that proper training improved their understanding on the physical structure of the PICC. This finding is also, supported by **Deshmukh and Shinde (2014)** ⁽²⁹⁾ who found that less than half of the participant's knowledge was poor before the intervention which became good after the post-test. As well as, there was an improvement in the mean score of knowledge during the post-test compared to the pre-test.

Concerning nurses' practice of PICC pre, immediately post and two months post- simulated based on education

implementation, the results indicated that the studied nurses' practice of regarding PICCs as assessment and preparation, dressing change, flushing and IV fluids, and medications was higher after immediately, and post two months simulated based education implementation than before with statistically significant difference. From the researcher's point of view, it is necessary to improve the nurses' skills that help them satisfy the special demands of neonates in the use of catheters placed in the peripheral vein that consequently reduce the occurrence of adverse events during hospitalization and reflected the effectiveness of pre, immediately post, and two months post simulated based education implementation. This finding is consistent with **Woody and Davis (2019)** ⁽³³⁾ who conducted a study, titled "Increasing nurse competence in peripheral intravenous therapy" and found that PICC insertion and maintenance are considered essential nursing skills for all practicing nurses and must be improved.

Moreover, the result is similar to **Sharpe (2013)** ⁽³⁴⁾ who found a broad range of PICC performance in many aspects of PICC placement and care. This finding is also, consistent with the findings of **Deshnukh and Shinde (2014)** ⁽²⁹⁾ who found that the majority of individuals scored between average practice scores in the pre-test before structured education and improved after structured education.

Results of the current study illustrated that the studied nurses had a satisfactory level of practice post- simulated-based education implementation. From the researchers' point of view, this reflected the positive effect of simulated-based education

implementation in improving practice among the studied nurses and was effective in enhancing the clinical practice level scores of the studied nurses.

This was in line with previous research studies by **Gomes et al. (2020)** ⁽³⁵⁾ who studied "Clinical simulation for the teaching of wound evaluation and treatment " and **Nuraini et al. (2015)** ⁽³⁶⁾ that studied the impact of simulation-based education on nursing students' practical achievements and found that simulation-based education improved their performance. Furthermore, when compared to other teaching approaches, **Beal et al. (2017)** ⁽³⁷⁾ who found that clinical simulation was a successful strategy for enhancing performance of studied students.

The finding of the current study revealed that a higher percentage of nurses reported a satisfactory level, post receiving the simulated-based education. This result is in the same line as this finding was by **Zapko et al. (2018)** ⁽³⁸⁾ who revealed that participants were satisfied with the experience of simulated education, felt confident in their practice, and felt the simulations were based on good educational practices and were crucial for learning. Also, the study carried out by **Saied (2017)** ⁽³⁹⁾ who studied "The impact of simulation on pediatric nursing students' knowledge, self-efficacy, satisfaction, and confidence "revealed that students were satisfied with the simulation experience and their self-confident scores were higher after the simulation session. Furthermore, **Mattson (2013)** ⁽⁴⁰⁾ who studied the effects of high fidelity simulation on knowledge acquisition, self-confidence, and satisfaction with Baccalaureate Nursing Students using the Solomon-Four research

design; stated that the students were very satisfied with the simulation learning activity.

The result of the current study revealed that there was a positive correlation between knowledge, practice, and nurses' satisfaction post receiving the simulated-based education regarding PICCs procedure. is consistent with **Abd Elbaky (2018)** ⁽¹¹⁾ who stated in his study about "Impact of a simulated education program on nurses' performance of invasive procedure at intensive care units" that, there was a positive correlation between knowledge, procedural intervention, and general performance after the simulation education program.

Conclusion

From the findings of the present study, it can be concluded that simulation-based education had a positive effect on improving nurses' performance and satisfaction regarding peripherally inserted central catheters.

Recommendations

Based on the current study findings, it can be recommended that:

- The establishment of written guidelines, administrative policy, and procedures for nursing measures about a peripherally inserted central catheter for normal and premature infants are needed to be reviewed and updated regularly.
- Continuous training for nurses working in NICU about the updates about peripherally inserted central catheters is recommended.

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