



# Impact of an Educational Program on Nurses' Performance in Providing Peripherally Inserted Central Catheter Care for Neonates

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## ABSTRACT

All nurses who care for neonates with peripherally inserted central catheters require enhanced awareness of the current practice guidelines and standards. This study evaluated the impact of an educational program on nurses' performance from May 2016 to July 2017 at 4 hospitals in Tehran, Iran. The performance of 80 nurses was observed and scored 3 times before the intervention. Four weeks after the last training session, their performance was observed with the same researcher, and the checklist was completed 3 times in different working shifts. Four 35- to 45-minute training sessions were completed with a 4-week follow-up. Results of the study indicated that training courses should be held every 6 months, including permanent or periodic feedback.

**Key words:** educational program, neonatal intensive care unit, neonate, nurses' performance, peripherally inserted central catheters

In recent years, the survival of premature infants has increased globally.<sup>1</sup> These infants are unable to meet their nutritional needs by mouth and, as a result, venous access is vital to provide them with intravenous (IV) fluids and medication. One method of achieving adequate nutrition and hydration is utilizing a peripherally inserted central catheter (PICC).<sup>2-4</sup> The advantages of using PICCs are as follows: (1) common side effects of short peripheral catheters, such as thrombosis, obstruction, and leakage, are reduced; (2) PICC insertions can take place within the hospital ward; and (3) PICCs allow safe infusions of drugs with high osmolality or with nonphysiological acidity.<sup>5</sup> Although PICCs in neonates and infants have benefits, they also have distinct

disadvantages. The use of PICCs can lead to an increased risk of sepsis, central line-associated blood stream infection (CLABSI), thrombosis, embolism, or other complications that ultimately lead to an increased length of hospitalization and hospital costs.<sup>4,6-8</sup> In one study, results showed 4.6 complications per 1000 catheter days that included occlusion (3.0%), infection (1.4%), leakage (2.0%), phlebitis (0.6%), displacement (1.0%), pleural effusion (0.6%), and breaks (0.6%) during 10 540 catheter-days.<sup>9</sup> One of the major causes of infection is lack of adherence to the National Association of Neonatal Nurses (NANN), *Peripherally Inserted Central Catheters: Guideline for Practice*<sup>10</sup> at the time of catheter insertion and maintenance. To improve patient outcomes and reduce health care costs, strategies must be devised to reduce the incidence of infections, and nursing personnel must utilize protocols and practical clinical guidelines for the insertion and maintenance of PICCs to prevent these complications.<sup>11,12</sup> In concordance with the results reported by Alkubati et al,<sup>13</sup> important factors in preventing infection include the education and training of health care providers who insert and care for central catheters or PICCs. Because PICCs are inserted and cared for by experienced nurses, the risk of complications could be dramatically decreased by improving the quality of nursing and professional education.<sup>13-15</sup> Training nurses is critical for the safe and effective care of patients. Raising the awareness, confidence, and psychomotor skills of nurses and proper maintenance of these catheters may affect patient care and ultimately improve patient outcomes.<sup>16</sup>

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Lack of standard knowledge regarding PICC care may potentiate complications and impacts the ability to safely provide infusion therapy. The continuing education provided to nurses is necessary to improve their clinical practice associated with the use of this device.<sup>17</sup> The care of newborns who need IV therapy requires particular knowledge and skills from nurses, especially knowledge regarding the anatomical and physiological characteristics, standards of growth and development, and related guidelines.<sup>18</sup> Use of evidence-based practice tools and guidelines is associated with improved care and potentially enhanced outcomes of patients.<sup>19</sup> Globally, nearly 1 million children die annually as a result of preterm birth complications.<sup>1</sup> Overall, the inability to use guidelines is reported in most areas, which simply indicates that merely providing guidelines does not ensure their usage.<sup>20</sup>

In 2018, the neonatal mortality rate (deaths per 1000 live births) was 9.6 in Iran.<sup>21</sup> Family-centered neonatal care with a concentration on brain development and kangaroo mother care have been implemented into level II and III infant care services, subsequent to the improvement of healthier infants with better brain development.<sup>22</sup> According to the regulations of the Ministry of Health in Iran, the indication, insertion, maintenance, and removal of PICCs have been the tasks of specialist nurses since 2013.<sup>23</sup>

## AIM

This study aimed at determining the impact of an educational program on the performance of nurses in providing PICC care for neonates in Iran.

## METHODS

### Setting and Sampling

This study was a quasi-experimental pretest–posttest design with a control group that was conducted from May 2016 to July 2017 on 80 nurses employed in the neonatal intensive care unit (NICU), (40 nurses in the intervention group and 40 nurses in the control group) at 4 hospitals in Tehran, Iran. Ali Asghar Children's Hospital ( $n = 16$ ) and the Children's Medical Center ( $n = 24$ ) were selected for the intervention group, and Arash Women's Hospital ( $n = 26$ ) and Hazrate Rasool Akram Medical General Hospital ( $n = 14$ ) were selected for the control group.

The sample size was determined at a CI of 95% and power of 80% with moderate effect size. A sample size of 40 for each group was considered adequate. The research environment was the NICU in governmental, referral, and teaching hospitals affiliated with 2 universities of medical sciences in Tehran. The researchers chose volunteer nurses in the NICU with inclusion criteria in their own workplace to be included in the study. The intervention group took part in an educational program about PICC care in addition to the usual service, including access to resources and in-service education, whereas the control group only received usual services.

This study required a checklist to evaluate the performance of NICU nurses in providing PICC care based on NANN's clinical practice guidelines<sup>10</sup> and the *Infusion Therapy Standards of Practice*.<sup>18</sup> As supported by previous research,<sup>24</sup> checklists can increase compliance with evidence-based practice guidelines.

### Instrument

The instrument used included 2 sections. The first section was related to the descriptive characteristics of the participant nurses, including age, education level, nursing experience, experience working in the NICU, shift work conditions, passing the educational course related to PICC care of neonates, and following any specific protocol for PICC care (Table 1). Each participant was identified by a unique code that kept all data anonymous. The second part was a 33-item researcher-made checklist that was prepared according to 3 areas, including: (1) flushing: 13 items (eg, washing hands, wearing sterile gloves, and using sterile drapes); (2) dressing change: 9 items (eg, emphasized hand washing, using sterile mask and gloves, and disinfecting the skin with a correct method and adequate timing); and (3) drug and fluid infusion: 11 items (eg, including washing hands before each injection, disinfecting the area of injection, using infusion pumps, using heparin, and using the correct technique of push-pause for flushing and locking); (Table 2). First, the checklist items were constructed through a detailed review of the clinical guidelines<sup>10,18,25</sup> and valid scientific articles regarding PICC use, thus assuring content validity. Face validity was determined by a group of 20 nurses', supervisors', physicians', and faculty members' experience in providing care to neonates. These individuals were asked to read and evaluate the checklist and judge the items for their clarity. As a result, a few changes were made in the sentence structure and wording of the items on the checklist. To measure the tool's reliability, the evaluation of agreement between observers was used. In this way, the performance of 15 NICU nurses was evaluated simultaneously by the researcher and the assistant researcher. Cohen's  $\kappa$  score was additionally used to analyze the homogeneity of each checklist variable. The obtained correlation coefficient (0.91) indicated the interobserver reliability. Based on Cohen, the value of 0.60 is minimally acceptable, and values of 0.75 or higher are very good.<sup>26</sup>

An expert committee and research team were recruited to review the checklist and content of education for NICU nurses. This committee consisted of 4 academic members of the nursing and midwifery faculty with PhD degrees, 2 physicians with fellowships in NICU, and 3 nurses with master's degrees in neonatal intensive care. The response scale was in the form of "yes" and "no." If the nurse conducted each phase correctly, she was given 1 point and otherwise 0. Thus, each item had a total score of 0 to 3, and the total score was equivalent to an average of 3 points for 3 observations.

TABLE 1

## Nurses' Characteristics

Variables	Control group (n = 40) n (%)	Intervention group (n = 40) n (%)	P value
Age (y)			.757
<30	17 (42.5)	15 (37.5)	
30–34	9 (22.5)	10 (25.0)	
35–39	9 (22.5)	9 (22.5)	
≥40	5 (12.5)	6 (15.0)	
Nurses' work experience (y)			.859
<5	10 (25.0)	9 (22.5)	
5–9	14 (35.0)	15 (37.5)	
10–14	9 (22.5)	12 (30.0)	
≥15	7 (17.5)	4 (10.0)	
Nurses' work experience in NICU (y)			.184
<5	10 (25.0)	9 (22.5)	
5–9	14 (35.0)	15 (37.5)	
10–14	9 (22.5)	12 (30.0)	
≥15	7 (17.5)	4 (10.0)	
Working conditions in shifts			.394
Fixed	7 (17.5)	4 (10.0)	
Rotational	33 (82.5)	36 (90.0)	
Passing educational course			.085
Yes	11 (27.5)	18 (45.0)	
No	29 (72.5)	22 (55.0)	
Following specific protocol			.491
Yes	17 (42.5)	14 (35.0)	
No	23 (57.5)	26 (65.0)	

Abbreviation: NICU, neonatal intensive care unit.

Four NICUs were selected in Tehran, each supervised by Iran and Tehran University of Medical Sciences. After obtaining written permission from the related officials and explaining the objectives of the study, informed consent was obtained from the nurses. Eighty-eight NICU nurses confirmed their participation in all phases of the study by written consent, and the study was carried out with their presence. They were also assured of the confidentiality of the information. The inclusion criteria included: holding a bachelor's degree, at least 3 months' experience in the NICU, and at least 3 years' experience working in health care centers. The researchers chose volunteers from their own workplace to be included in the study. Proportions of staff enrolled in intervention and control groups were 83.3% and 88.8%, respectively. The exclusion criteria included not attending more than 1 educational session.

Nurses' performance regarding PICC care of neonates in both the intervention and control groups was assessed based on the researcher-made checklist, the reliability and validity of which have been proven earlier. The assessment was conducted in three 8-hour shifts (morning, afternoon, and overnight), with nurses' awareness; however, they did not know exactly when they were being recorded. The score of each nurse was the mean performance in 3 observations. After completion of the pretest, the nursing education program about PICC care in neonates according to valid clinical guidelines<sup>10,18</sup> was prepared and also confirmed by 10 NICU nurses and expert panel members. Then, the program was carried out in the intervention group in small 5- to 6-member groups. The meeting of education was held in the hospital itself, as previously prepared. Four 1-hour training sessions were held in the training room of the NICU ward. Each session was divided into 3 parts. In the first 30 minutes, scientific content and theories related to the subject were taught in the form of lectures and PowerPoint presentations. The second 30 minutes was divided into 2 parts; in the first 15 minutes, the procedure was conducted on moulage and the next 15 minutes was allocated to questions and group discussions. At the beginning of each new session, a summary of the material previously presented was given. In the last session, bedside teaching was done by the researcher by providing a complete description of the procedure (Table 3). The poster image that was adopted from the approved educational content regarding the 3 areas of change, dressing, flushing, and drugs and fluid infusion, was installed in a location in the ward that was visible to all NICU nurses in the intervention group.

Four weeks after the last training session, the researchers observed all nurses in the experimental group and the control group once more. The same researcher completed the checklist for the intervention and control groups in three 8-hour shifts (morning, afternoon and overnight), while the nurses' performance was scored. The average score of the nurses' performance was calculated 3 times.

### Ethical Considerations

This study was approved by the ethics committee of Iran University of Medical Sciences (code: IR.IUMS.REC.1395.9211451204), and the researchers abided by the Helsinki Declaration. The nurses provided informed verbal and written consent. The letter of information contained the purpose of the study, assurance that the data collection would be done voluntarily, and the name of the university where the research was going to be performed. The letter also noted that participants have the right to withdraw at any point during the trial. At the conclusion of the study, all educational content was given to the control group. This study was registered in the Clinical Trial Registration Center under code No. IRCT2017012831260N1.

**TABLE 2****Researchers' Checklist**

Variables	Statements	Yes	No	Not complete/ not seen
Flushing	<ul style="list-style-type: none"> <li>• Explain PICC procedure and their child's needs to family</li> <li>• Wash hands thoroughly</li> <li>• Wear sterile gloves</li> <li>• Use sterile sealant around the central catheter</li> <li>• Open the other 10-mL syringe halfway to keep the tip of the syringe clean</li> <li>• Hold on to the PICC, clean the very end of needle-free connector thoroughly with the sterile alcohol wipe</li> <li>• The solution is left to dry naturally</li> <li>• Use a syringe larger than 10 mL to flush the catheter</li> <li>• Uses normal saline sterile solution to flush the catheter</li> <li>• Use the solution with an appropriate volume of 0.5 to 1.0 mL</li> <li>• Use the push/pause technique to flush the catheter</li> <li>• After the catheter is flushed, it is then clamped</li> <li>• Removes the syringe and disinfects the cap again with an alcohol swap and attaches the injection set</li> </ul>			
Dressing change	<ul style="list-style-type: none"> <li>• Pain management</li> <li>• Hand hygiene</li> <li>• Dons mask</li> <li>• Prepare supplies aseptically onto sterile dressing tray</li> <li>• Don clean gloves</li> <li>• Removes old dressing ensuring PICC is stabilized</li> <li>• Removes stabilization device using approved antiseptic swab stick</li> <li>• Removes clean gloves, performs hand hygiene</li> <li>• Dons sterile gloves, remove old transparent dressing by gently pulling in upward direction</li> </ul>			
IV fluids and medications	<ul style="list-style-type: none"> <li>• Hand hygiene</li> <li>• Before each experiment, clean the injection ports with alcohol</li> <li>• Performs alcohol cleaning for at least 15 seconds</li> <li>• The solution is left to dry naturally</li> <li>• Uses infusion pumps for solution administration</li> <li>• To keep catheter patent use heparin 0.5 to 1.0 unit/mL</li> <li>• Uses syringes 10 mL and larger to inject drugs</li> <li>• Performs administration of drugs with the correct push/pause technique</li> <li>• In the event of drug interactions, stop the infusion and flush the catheter</li> <li>• Does not use a catheter to infuse blood products</li> <li>• Do not use a catheter to take blood samples</li> </ul>			

Abbreviations: IV, intravenous; PICC, peripherally inserted central catheter.

After completion of the final evaluations, the committee approved the training package, which included educational content in the form of manuals, posters, and pamphlets, and was delivered to NICU nurses of the control and intervention groups.

### Data Analysis

Data were collected and analyzed using SPSS version 18 (IBM Inc, Armonk, NY) software. The Kolmogorov–Smirnov test was used to check the normal distribution of quantitative variables. The  $\chi^2$  test was performed to compare independent groups for nominal data and Student paired and unpaired *t* tests for continuous data.

## RESULTS

The participants' enrollment flow chart is displayed in Figure 1. All nurses were women, with an average age in the control and intervention group of  $32.07 \pm 5.46$  years and

$32.47 \pm 6.02$  years, respectively. Nurses' work experience in the control group was  $8.28 \pm 5.12$  years and  $8.48 \pm 5.31$  years in the intervention group. The average years of nurses' work experience in the NICU in the control group was  $5.18 \pm 3.35$  years and  $6.44 \pm 4.87$  years in the intervention group. Concerning the working condition and shifts, both groups were homogenous. In fact, more than half of the nurses in both groups were in rotational shifts. More than half of the nurses in both groups had not passed any specific course regarding PICC care. The majority of nurses in both groups stated that they did not follow any specific protocol for PICC care (Table 1).

There were no statistically significant differences between the characteristics of the participating group (intervention and control groups) and the withdrawn participants ( $n = 8$ ) in the first phase. Nurses' performance of PICC care was assessed in 3 main areas: flushing, dressing and medication change, and fluid infusion. Nurses' performance was assessed separately in each of these areas. Results of covariance analysis showed that, after the

**TABLE 3****Brief Description of Intervention**

Sessions	Brief description of intervention	Duration (min)
First	<ul style="list-style-type: none"> <li>• Introduction, physiology and anatomy, importance of the PICC</li> <li>• Common complication of PICCs in NICU</li> <li>• Group discussion and sharing experiences were conducted</li> </ul>	30 15 15
Second	<ul style="list-style-type: none"> <li>• The issues from the previous session were reviewed and questions were answered</li> <li>• Importance of flushing</li> <li>• Wash hands thoroughly</li> <li>• Exercise I: practicing on moulage</li> <li>• Exercise II: practicing on a real case</li> </ul>	10 10 10 10 20
Third	<ul style="list-style-type: none"> <li>• The issues from the previous session were reviewed and questions were answered</li> <li>• Activities were reviewed</li> <li>• Importance of change dressing</li> <li>• Discussions were held among nurses about the change dressing</li> <li>• Dons mask</li> <li>• Prepare supplies aseptically onto sterile dressing tray</li> <li>• Dons clean gloves</li> <li>• Exercise I: practicing change dressing on moulage</li> <li>• Exercise II: practicing on real case</li> </ul>	5 5 5 5 2 10 3 10 20
Fourth	<ul style="list-style-type: none"> <li>• The issues from the previous session were reviewed and questions were answered</li> <li>• Discussions were held among nurses about previous sessions</li> <li>• Discussions were held among nurses about nurses about IV fluids and medications</li> <li>• Booklets were distributed containing:               <ol style="list-style-type: none"> <li>1. Information about PICC use/care</li> <li>2. CDs/Videos about PICC use/care</li> </ol> </li> <li>• Exercise I: IV fluids and medications on moulage</li> <li>• Exercise II: Practicing on real cases</li> </ul>	5 5 5 10 10 10 20
Week 2/first phone call	<ul style="list-style-type: none"> <li>• Questions were answered</li> </ul>	15–20
Week 4/second phone call	<ul style="list-style-type: none"> <li>• Questions were answered</li> <li>• The intervention was closed.</li> </ul>	15–20 15–20

Abbreviations: CDs, compact discs; IV, intravenous; NICU, neonatal intensive care; PICC, peripherally inserted central catheter.

intervention, the performance score in each of the areas among the nurses of the intervention group was higher than the control group. The average score of nurses in the control group changed from  $53.70 \pm 6.40$  to  $47.48 \pm 8.32$  and from  $56.71 \pm 5.86$  to  $72.84 \pm 7.82$  in the intervention group (Table 4).

Considering the independent *t* test, after the educational intervention, the average score of the nurses in the intervention group was higher. Considering numerical indicators, changes in the performance scores and the areas before and after the educational intervention, the following results were obtained in both control and intervention groups: a change in the performance score in the control group was  $6.22 \pm 11.58$ , whereas in the intervention group it was  $16.13 \pm 11.45$  (Table 4).

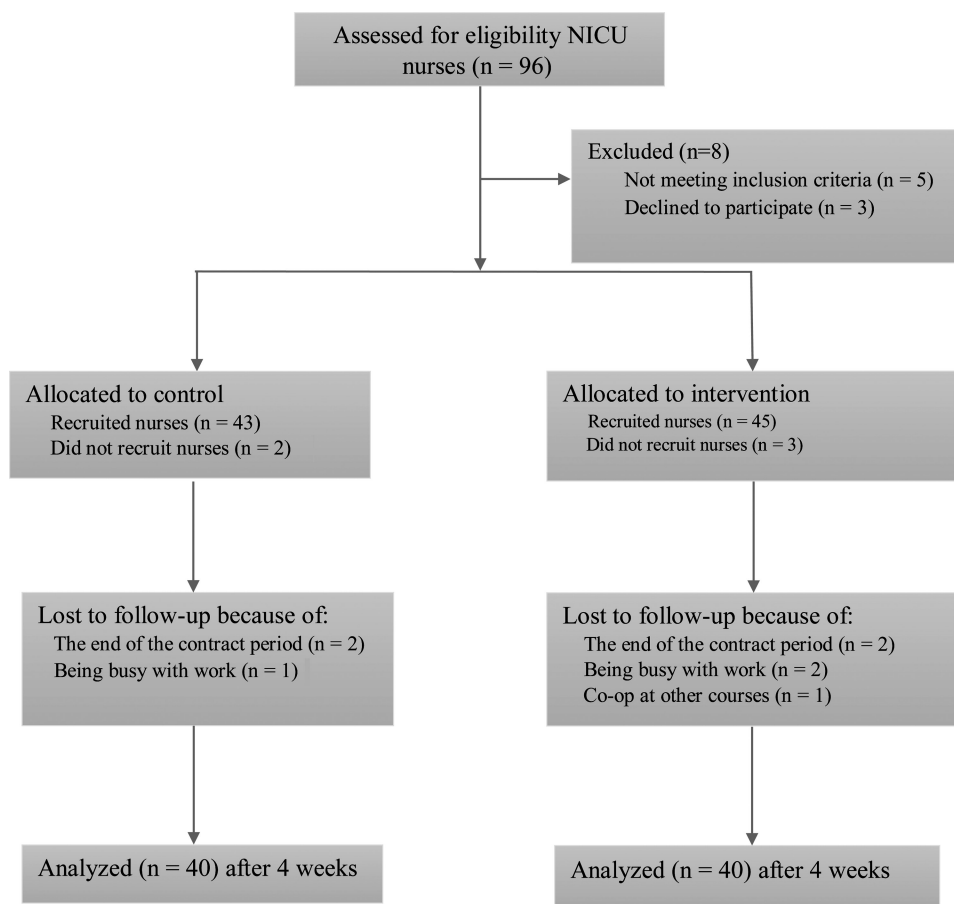
## DISCUSSION

According to the results of this study, the educational program improved the total score of nurses' performance regarding PICC care. Considering the 3 areas studied, the

most significant change was related to improving performance in dressing changes (21.27 increase) and the least change was in flushing (11.24 increase). The findings in this study are confirmed by another study by Gerole mou et al in 2014,<sup>27</sup> who used simulation techniques to teach the nurses central vascular catheter care to decrease CLABSI and evaluated the nurses' performance before and after the intervention. They concluded that the average score of nurses' performance before the intervention was weak, but after simulation-based education, their score was significantly increased. Roslien and Alcock<sup>16</sup> indicated that educational intervention regarding PICC care, which included showing skill and theoretical education, could significantly increase the knowledge, self-confidence, and psychomotor skills of nurses that could be maintained for 3 months.<sup>16</sup> In this study, the nurses' performance was improved and maintained 1 month after the intervention.

Lima et al<sup>28</sup> suggested targeting educational programs to improve performance. Moreover, in-service training programs, multifaceted educational interventions, and follow-up programs are necessary for adoptive changes





**Figure 1** Diagram of the NICU nurses' enrollment in the study. *Abbreviation: NICU, neonatal intensive care unit.*

from initiation to outcome. However, such programs may result in short-term effects in the behavior of health care providers. If education were not continuous and repetitive, there would be no long-term improvement in behavior.<sup>28</sup>

Therefore, researchers used reminders such as posters, manuals, and pamphlets for the continuity effect of education on the performance of nurses, and after 1 month, they assessed the nurses' performance, which was improved.

**TABLE 4**

## Comparison of Nurses' Performance Scores

Performance score (0-100)	Group	Preintervention group (n = 40) Means (SD)	Postintervention group (n = 40) Means (SD)	P value
Flushing	Intervention	58.36 (9.4)	69.60 (7.9)	<.001
	Control	50.69 (8.3)	43.36 (12.9)	.011
	P value	<.001	<.001	
Dressing change	Intervention	52.89 (6.8)	74.16 (10.8)	<.001
	Control	47.37 (7.0)	38.97 (6.5)	.001
	P value	.001	<.001	
Medication and fluid infusion	Intervention	58.88 (9.4)	74.77 (8.8)	<.001
	Control	63.05 (8.2)	60.10 (13.9)	.262
	P value	.038	<.001	
Total score	Intervention	56.71 (5.9)	72.84 (7.8)	<.001
	Control	53.70 (6.4)	47.48 (8.3)	.002
	P value	.031	<.001	

## LIMITATIONS

Researchers in this study used a convenience sampling method, and representation of the general population was limited. One of the other limitations was the presence of the researcher, which may have affected the nurses' performance. Therefore, the researcher was present in the wards for several hours during multiple shifts as a means to reduce her presence and to record the nurses' performance in real time. To reduce the effect of this confounding factor, each procedure was analyzed 3 times. In the control group, according to performance scores, the influence of the researcher's presence on nurses' performance was obvious during the first round of data collection, and this affect decreased the second round (Table 4). Also, in the intervention group, the poster images were installed in a location in the ward that was visible to all NICU nurses in the intervention group and could increase nurses' performance scores.

## IMPLICATIONS FOR NURSING PRACTICE

The research findings presented in this study add to knowledge about factors that have an impact on nurses' performance. There is a necessity to educate NICU nurses and enhance constant monitoring to improve neonate outcomes. The educational program based on the standards of practice and use of simulation demonstrated an improvement in the quality of care provided for PICC care as indicated by the performance scores.<sup>27</sup> The research findings presented in this article indicated the use of simulation to increase adherence to standards of practice and future research suggested on long-term compliance.

## CONCLUSION

The results of this study indicated that nurses' performance could be improved with the help of nursing education programs in PICC care, and hence result in improving the quality of health care services. Consequently, it is important to use an appropriate simulation for all educational goals and outcomes. Furthermore, adherence to an organization's standards of practice may increase the confidence and autonomy of nurses in changing their clinical practices.

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