Journal of
Babol University of Medical Sciences
JBUMS
e-ISSN: 2251-7170 p-ISSN: 1561-4107

# An Audit of Nursing Care and Placement of Peripherally Inserted Central Catheter in Infants

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**Article Type**
**Research Paper**

**Received:**
**Jun 15th 2022**
**Revised:**
**Dec 25th 2022**
**Accepted:**
**Mar 15th 2023**

## ABSTRACT

**Background and Objective:** The performance quality of peripherally inserted central catheter (PICC) by nurses has a direct effect on the improvement of patient care and safety. The aim of this study is to audit the placement and nursing care of PICC in infants.

**Methods:** This cross-sectional study was conducted on 130 PICC procedures in the neonatal intensive care units of Rouhani and Amirkola hospitals in Babol in 2018-2021. All infants who needed PICC placement for any reason were selected. In order to collect the data, the observational researcher-made checklist and the infant demographic characteristics questionnaire were used. The checklist included 44 questions and four parts of nursing care before catheter insertion, hand washing, nursing care during the procedure, and nursing care after catheter placement. The scores obtained from the checklist were classified into conversion percentage and two groups of unfavorable placement (less than 67) and favorable placement (68-100). To confirm its reliability, intraclass correlation coefficient was used (ICC=0.90).

**Findings:** A total of 130 cases of PICC placement and nursing care were audited (Rouhani Hospital 98 cases 75.4%, Amirkola 32 cases 24.6%). In the studied sample, 83 (63.8%) were boys and 53 (43.1%) were diagnosed with prematurity. The most common PICC location was the armpit (42.3%). The percentages of compliance of nursing care before PICC insertion according to the standard (97.43%), hand washing (100%), nursing care during the procedure (87.14%) and nursing care after PICC insertion (94.84%) were favorable. Nurses did not use glasses and ultrasound guidance during PICC insertion; (85.4%) and (90%), respectively.

**Conclusion:** According to the results of this study, although the quality of PICC insertion and care in three stages was at a favorable level, nurses need training regarding the use of glasses and ultrasound guidance during PICC insertion.

**Keywords:** *Infant, Catheterization, Catheter, Nursing Audit, Nursing Care, Intensive Care Unit.*

**Cite this article:** Rezapour S, Haghshenas Mojaveri M, Aziznejadroshan P, Hajian-Tilaki K, Alizadeh Rokni S, Jahangir T. An Audit of Nursing Care and Placement of Peripherally Inserted Central Catheter in Infants. *Journal of Babol University of Medical Sciences*. 2023; 25(1): 134-42.



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## Introduction

The central venous catheter is placed through the peripheral vein and its tip is fixed in the superior vena cava (1). Peripherally Inserted Central Catheters (PICC) are usually used for long-term intravenous treatment, blood transfusion, nutrition and frequent blood sampling (2). When infants are very low birth weight or critically ill, they are often unable to receive adequate gastrointestinal nutrition during the weeks after birth and usually require injections of hyperosmotic or stimulant medications (3). Repeated intravenous catheterization will increase pain and the possibility of infection (4). Therefore, the establishment of long-term venous access with hyperosmotic resistance is very important for rescue therapy in neonates (5). PICC implantation is considered a safe, efficient and cost-effective intravenous device due to its long duration of remain, reduced vascular damage without repeated punctures, and convenient insertion and removal without the need for general anesthesia or deep incisions and suturing of wounds (2-9). PICC provides a circulatory pathway for successful rescue and treatment of infants, especially very low birth weight and critically ill infants, and avoids issues such as infection and pain from repeated punctures (5).

While the PICC catheter can remain in place for a long time, mechanical and infectious complications (central line-associated bloodstream infections), thrombosis, and acute bleeding occur during PICC placement or care (10). Approximately 30,000 cases of central line-associated bloodstream infections (CLABSI) occur annually in the United States, mostly during catheter care (10). CLABSI is the most common healthcare-associated infection and is most likely associated with organ failure and mortality in critically ill children (11). A systematic review showed that approximately 30% of PICCs failed before completion of treatment due to complications that led to delays in drug administration and blood sampling, while increasing financial burden and decreasing satisfaction (12). Central Line Bundle (CLB) guidelines were proposed by the Australian Institute of Health and Medicine and include five key measures of hand hygiene before PICC insertion and care, maximum sterility during PICC insertion and care, use of chlorhexidine disinfectant, choosing the best place to puncture and checking the catheter daily to avoid displacement (13). It is important to examine the effectiveness of CLB guidelines in preventing bloodstream infections in very low birth weight infants (11). Premature babies are prone to sepsis due to weak immune system and frequent calls from hospital personnel and invasive procedures. Catheter-associated bloodstream infection increases mortality and morbidity (14). An experienced nurse will increase the success of the placement by early diagnosis of PICC candidate baby, timely placement and knowledge of the vein and its anatomy and choosing the appropriate vein (14). Previous studies reported that proper PICC care may offset the risk of injuries and maximize PICC safety (15-18). Nurses' knowledge and skills regarding PICC care directly affect the quality of care, clinical outcomes, and patient safety (19, 20).

The results of the study by Wang et al. showed that the use of CLB guidelines can be effective in preventing catheter-associated infection and prolonging its survival time in very low birth weight infants (21). The results of the study by Yarveisi et al. showed that the level of conformity of care with the desired condition had an acceptable score, but the nursing care related to vascular access in neonatal intensive care units was average, which shows that the level of care is far from the standards and more importance should be given to nursing education (22). In their study, Xu et al. reported that criteria related to PICC dressing change showed moderate to high compliance (23). Oliveira et al. showed that PICC care had moderate (65%) to high (100%) compliance with the standard (8).

Auditing is one of the dimensions of clinical governance and one of the major methods of improving and evaluating the quality of nursing care (24). The purpose of the audit is to improve the quality of services and care provided to patients and its results (24). Nursing audit is one of the precise control methods through which the strengths and weaknesses of nursing care are determined, and in the neonatal intensive care unit, nurses are the first to identify the potential risks and critical situations of infants and take action to resolve them (25).

Since the quality of nurses' practical performance in PICC care has a direct effect on the improvement of patient care and safety, a study that measures the practical performance of nurses should be conducted so that it can be measured directly by observation in accordance with the standard (23). Although PICC has been widely used in neonates in recent years, its compliance with nursing and care guidelines based on a standard guideline (CLB) has not been evaluated, and there is insufficient information in this area. Moreover, educational gaps in the use of PICC catheters are an obstacle to improving performance and patient safety, so compliance with best evidence-based practices should be evaluated in all audit criteria. Therefore, this research was conducted with the aim of auditing the placement and nursing care of PICC in infants hospitalized in neonatal intensive care units of affiliated hospitals of Babol University of Medical Sciences.

## Methods

After being approved by the Ethics Committee of Babol University of Medical Sciences with the code of ethics IR.MUBABOL.HRI.REC.1397.259, this cross-sectional study was conducted on infants hospitalized in the neonatal intensive care units of Ayatollah Rouhani and Amirkola hospitals in Babol from January 2019 to April 2021. 130 procedures of PICC insertion and nursing care in infants were observed (once for each procedure) and the checklist was completed based on the observations. Both time sampling and event sampling methods were used. The method of event sampling (procedure) was carried out systematically by two trained observers in a non-participatory manner. The number of samples was estimated to be 130. This number of samples is based on the information available in similar studies (26) and the standard deviation of the placement evaluation score is SD=20, at confidence interval of 95% and the power of the test is 80%, and a difference of 5 units from the standard can be identified.

All infants who were hospitalized for any reason and any kind of diagnosis and required PICC for any reason including long-term hospitalization or receiving multiple intravenous drugs and fluids or the inability to access peripheral vessels were included in the study. Infants with anatomical problems in organs and peripheral neuropathy were excluded from the study.

In order to collect information, a questionnaire was used to describe the infant’s demographic characteristics (weight, gender, gestational age, disease diagnosis, infant’s age at the time of PICC insertion and PICC insertion location). To collect the audit data on the placement and nursing care of PICC, a researcher-made checklist was used in accordance with the CLB standard instructions. This checklist consists of four parts, which include nursing care before catheter insertion (6 questions), hand washing before catheter insertion (11 questions), nursing care during the procedure (17 questions) and nursing care after catheter placement (10 questions). This checklist includes a total of 44 questions that were designed as yes and no answers (13). The “yes” answer was given to the actions that should be done correctly, and the “no” answer was assigned to the actions that were not done or not done correctly. After that, the scores obtained from the checklist were converted into percentages and the scores for each checklist were

calculated. These scores were classified into two groups of PICC placement and nursing care: unfavorable (less than 67) and favorable (68-100). In the checklist, the total score was determined as the mean percentage of compliance.

To determine the validity of the checklist, the method of determining content and face validity index was used. For this purpose, the terms of the checklist were judged by 10 experts (nurses working in the neonatal intensive care unit, members of the nursing faculty and neonatology specialists) in terms of the relevance, clarity, simplicity and smoothness of the questions. The opinions of these people were reviewed by the research team and the agreed items were modified and confirmed with CVR=0.83, CVI=0.78. To confirm the reliability of the checklist before use, the method of calculating the coefficient of agreement between observers was used (ICC=0.90).

Data were analyzed using SPSS statistical software, and descriptive statistical index was used to evaluate PICC insertion. Based on the checklist of CLB instructions, the mean percentage of compliance of nurses' performance in PICC insertion was calculated, and the percentage of compliance with an assumed number of 80% was tested by t-test and $p<0.05$ was considered significant.

## Results

98 cases (75.4%) in Ayatollah Rouhani Babol hospital, and 32 cases (24.6%) in Amirkola Children's Hospital were audited among a total of 130 procedures of PICC placement and nursing care. The mean weight of the infants was 2001.62±5.974 grams and the mean gestational age was 32.3±4.42 weeks (Table 1).

Regarding the nursing care audit before performing the PICC insertion procedure, the checklist for determining the identity of the infant, determining and marking the vein or the appropriate place for the catheter to enter, giving the infant a suitable position, checking all the tools and equipment needed to place the PICC for 130 cases (100%) was completed and relevant documentation (forms and charts) was observed in 129 cases (99.2%), and in terms of examining the patient's anticoagulant treatment status, 19 cases (14.6%) were not controlled. Regarding the audit of hand washing before PICC insertion, all items of the checklist were observed in the 130 items (100%).

Regarding the audit of nursing care during the PICC insertion procedure, in 111 (85.4%) cases, the person who inserted the PICC did not wear glasses. 11 cases (8.5%) did not use mask and 117 cases (90%) did not use ultrasound or fluoroscopic guidance during PICC insertion procedure (Table 2).

Regarding the audit of nursing care after PICC insertion procedure, 16 cases (12.3%) did not use Biopatch antimicrobial dressing. 25 cases (19.2%) refused to change the PICC dressing after 24 hours by aseptic method (with sterile dressing set and sterile gloves).

Data analysis showed that the mean nursing care before PICC catheter placement in infants (97.43±6.03), hand washing (100.00±0.00), nursing care during the procedure (5.63±87.14) and nursing care after PICC placement (94.84±9.74) was at a favorable level (Table 3).

The mean percentage of compliance of nurses' performance observed in the area of nursing care audit before PICC insertion procedure and nursing care after PICC insertion procedure was subjected to t-test with an assumed number of 90%. The findings showed that the observed performance was significantly more than 90% (p=0.001). Also, the mean percentage of compliance of nurses' performance observed in the area of nursing care audit during PICC insertion procedure was subjected to t-test with the assumed number of 80%. The findings showed that the observed performance was significantly more than 80% (p=0.001).

**Table 1. Demographic characteristics of the infants and the distribution of the place and type of PICC insertion procedure**

| Variable | n=130 Number(%) |
|---|---|
| **Hospital name** | |
| Amirkola | 32(24.6) |
| Rouhani | 98(75.4) |
| **Gender** | |
| Boy | 83(63.8) |
| Girl | 47(36.2) |
| **Disease diagnosis** | |
| Premature | 53(43.1) |
| Respiratory distress syndrome | 32(26) |
| Other causes | 38(30.9) |
| **Placement of PICC catheter** | |
| Basilica | 24(18.5) |
| Brachial | 40(30.8) |
| Femoral | 1(0.8) |
| Saphenous | 9(6.9) |
| Axillary | 55(42.3) |
| Other | 1(0.8) |
| **Type of PICC insertion procedure** | |
| Selective | 116(89.2) |
| Emergency | 14(10.8) |

**Table 2. Nursing care audit during PICC insertion procedure**

| **Actions** **Checklist questions** | **Yes Number(%)** | **No Number(%)** | **Total Number(%)** |
|---|---|---|---|
| Does the catheter inserter wear a mask? | 129(99.2) | 1(0.8) | 130(100) |
| Does the catheter inserter wear glasses? | 19(14.6) | 111(85.4) | 130(100) |
| Is the person inserting the catheter wearing a sterile gown? | 129(99.2) | 1(0.8) | 130(100) |
| Is the person inserting the catheter wearing sterile gloves? | 129(99.2) | 1(0.8) | 130(100) |
| Are all the personnel in the room wearing masks? | 119(91.5) | 11(8.5) | 130(100) |
| Is the environment sterile? | 129(99.2) | 1(0.8) | 130(100) |
| Do the assistants follow the sterile recommendations? | 126(96.9) | 4(3.1) | 130(100) |
| Was the whole body scrubbed from the tip of the finger to the end before puncturing the place, without drying or rubbing or blowing, etc.? | 130(100) | - | 130(100) |
| Has the baby been covered with a large sterile cloth after scrubbing? | 130(100) | - | 130(100) |
| Is ultrasound or fluoroscopic guidance used? | 13(10) | 117(90) | 130(100) |
| Are the catheter ventilated and all routes clamped? | 130(100) | - | 130(100) |
| Has local anesthesia or sedation been used? | 117(90) | 13(10) | 130(100) |
| Was chlorhexidine solution used to disinfect the skin of the PICC insertion site? | 111(85.4) | 19(14.6) | 130(100) |
| Is the catheter fixed with stitches or glue? | 126(96.9) | 4(3.1) | 130(100) |
| Is the catheter fixed? | 130(100) | - | 130(100) |
| Has a sterile dressing (gauze, transparent dressing, etc.) been done? | 129(99.2) | 1(0.8) | 130(100) |
| Has the heart rate, heart rhythm, respiration and oxygen saturation been monitored while doing the work? | 130(100) | - | 130(100) |

**Table 3. The mean percentage of conformity of the audit of the placement and nursing care of PICC of newborns hospitalized in the neonatal intensive care units of Babol University of Medical Sciences hospitals**

| The audit of PICC care | Match percentage Mean±SD | Min | Max | Standard error of the mean |
|---|---|---|---|---|
| Nursing care before PICC insertion procedure | 97.43±6.03 | 83.33 | 100.00 | 0.52945 |
| Hand washing before insertion and nursing care of PICC | 100.00±0.00 | 100.00 | 100.00 | 0.00000 |
| Nursing care during PICC insertion procedure | 87.14±5.63 | 64.71 | 100.00 | 0.49629 |
| Nursing care after PICC insertion procedure | 94.84±9.74 | 70.00 | 100.00 | 0.85457 |

## Discussion

In this study, the audit of the placement and nursing care of the PICC of infants admitted in the neonatal intensive care unit of the affiliated hospitals of Babol University of Medical Sciences is at an optimal level. The percentage of compliance of nursing care before PICC catheter placement with the standard (CLB) in infants (97.43%) and hand washing (100%), nursing care during the procedure (87.14%) and nursing care after PICC insertion (94.84%) has been optimal, which shows that the level of compliance with the standards is ideal.

The results of a study by Okati et al. showed that the quality of PICC care in terms of placement, nursing care, and dressing change in the neonatal special care units of Mahdieh Medical Education Center in Tehran was at an optimal level (26). The results of this research are consistent with our study. However, Yarveisi et al. showed that regarding the degree of compliance of PICC nursing care with the desired condition, the score is acceptable, but overall, the percentage of compliance of care with the desired condition and nursing care for vascular access is average in neonatal intensive care units (62.28%), which shows that the level of care is far from the standards and more attention should be paid to nursing care education (22). In addition, a study by Oliveira et al. showed that the PICC audit in the intensive care unit of a Brazilian teaching hospital had moderate (65%) to high (100%) compliance and was far from the standards. The criteria that achieved the highest compliance with best practice recommendations were related to prevention of bloodstream infection and PICC removal due to obstruction (8). The knowledge of PICC maintenance and care among nurses in Hunan Province, China was at an average level (23), which is not consistent with the present study. It seems that the placement of PICC in the neonatal intensive care units of affiliated hospitals of Babol University of Medical Sciences by experienced and trained nurses, in addition to reducing possible complications, improved the quality of newborn care and increased its compliance with care standards.

The findings of the present study showed that glasses in 85.4% of cases and masks in 8.5% of cases were not used by the person who inserts PICC. Also, in terms of examining the anticoagulation treatment status of the patient, it was not controlled in 14.6% of cases. Failure to use glasses and masks increases the risk of secondary sepsis caused by bacterial colonization of the clot, and frequent venous thrombosis is a risk factor for PICC catheter dysfunction (27).

In the present study, 10% of the performed procedures did not use anesthetic and sedative drugs for PICC placement. Children who received local anesthesia required a greater number of attempts for successful PICC compared to those who did not receive local anesthesia (28). About 90% of the procedures were inserted without the use of ultrasound or fluoroscopic PICC guidance, while the study of Badheka et al. showed that the use of ultrasound or ultrasound guidance in 61.2% of cases can facilitate the process of

PICC insertion and reduce the rate of complications (29). In a study by Sharpe et al., 49.4% of respondents reported that they used chlorhexidine gluconate for skin disinfection (30). However, in the present study, only in 14.6% of cases, chlorhexidine solution was not used to disinfect the PICC insertion site, and this solution was used in the rest of the procedures (85.4%). Due to skin sensitivity in a number of infants to chlorhexidine solution, betadine was used instead to disinfect the PICC insertion site.

Regarding nursing care audit after PICC insertion procedure, 12.3% of cases did not use BIOPATCH antimicrobial dressing. 19.2% of cases refused to change the PICC dressing after 24 hours by aseptic method (with sterile dressing set and sterile gloves) and the rest of the procedures were performed with antimicrobial dressing and dressing change by aseptic method. In their study, Xu et al. reported that criteria related to PICC dressing change showed moderate to high compliance (23). Sharpe et al. also stated that most nurses were able to perform well in changing PICC dressings (19). The results of these studies are consistent with our study.

Overall, the findings of the present study showed that the auditing and nursing care of PICC in three stages was at a favorable level, but nurses need training regarding the use of glasses and ultrasound guidance during PICC placement. The results of this research can be used to inform managers about the quality of nursing services related to the placement and nursing care of peripherally inserted central catheter of infants admitted to neonatal intensive care units and developing an educational program to hold specialized trainings for nurses on the correct principles of care before, during and after PICC placement. It also increases the awareness of nurses about the relevant care and helps them to find the weak points and underlying defects of the system in order to try to improve the quality of nursing services while applying codified standards and implementing corrective measures.

## Acknowledgment

Hereby, the Vice Chancellor of Research and Technology of Babol University of Medical Sciences is gratefully acknowledged for the financial support of the research and all the nurses of the neonatal intensive care units of Ayatollah Rouhani and Amirkola Children's Hospitals who participated in the study.

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