

EVALUATING THE RESULTS OF PERIPHERALLY INSERTED CENTRAL CATHETER TECHNIQUE AND RELATED FACTORS IN NEONATES AT PHU THO PROVINCIAL OBSTETRICS AND PEDIATRICS HOSPITAL

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ABSTRACT

Objective: To evaluate the results of peripherally inserted central catheter technique and describe factors related to the results of insertion and maintenance of peripherally inserted central catheter in neonates at Phu Tho provincial Obstetrics and Pediatrics Hospital in 2025.

Methods: A cross-sectional descriptive study analyzed over 120 cases of peripherally inserted central catheter in 116 neonates from January 2024 to September 2025.

Results: The majority of peripherally inserted central catheter placements were successful (96.7% after intervention). 80.8% of catheters were in the correct central position immediately after insertion. The average duration of catheter maintenance was 18.1-19.35 days. The rate of central line-associated bloodstream infection was significantly higher in neonates with lower gestational age ($p = 0.026$) and lower birth weight ($p = 0.021$). Non-central tip position increased the risk of infection by 3.9 times compared to central position ($p = 0.017$).

Conclusion: Peripherally inserted central catheter is a highly effective technique for long-term infusion in neonates. Low birth weight, low gestational age, and non-central catheter tip position are significant risk factors for complications, especially central line-associated bloodstream infection.

Keywords: PICC, neonates, CLABSI, Phu Tho provincial Obstetrics and Pediatrics Hospital.

1. INTRODUCTION

The care of critically ill neonates, particularly extremely preterm infants, requires the maintenance of safe and long-term venous access for total parenteral nutrition and administration of specialized medications. Conventional peripheral intravenous methods are often associated with vascular trauma and an increased risk of infection and tissue necrosis due to extravasation when hyperosmolar solutions are used [1].

Peripherally inserted central catheter (PICC) placement has become the gold standard in neonatal intensive care because of its advantages in long-term catheter retention, reduction in the number of invasive procedures, and lower rates of severe complications compared with centrally inserted central venous catheters via the internal jugular or femoral veins [2]. However, the effectiveness of PICC placement and

the incidence of complications—such as central line-associated bloodstream infection (CLABSI) and catheter occlusion—are closely dependent on procedural practices and patient characteristics at each healthcare facility.

Phu Tho Provincial Obstetrics and Pediatrics Hospital has routinely implemented this technique; nevertheless, a systematic evaluation of factors associated with PICC placement outcomes and catheter maintenance remains essential to further improve the quality of care. Therefore, this study was conducted with two objectives:

1. To evaluate the outcomes of PICC placement at Phu Tho Provincial Obstetrics and Pediatrics Hospital in 2025;
2. To describe factors associated with PICC placement success and catheter maintenance in this population.

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2. SUBJECTS AND METHODS

2.1. Study population, setting, and study period

The study sample comprised 120 PICC placement procedures performed in 116 neonates who were admitted to the Neonatal Emergency and Intensive Care Unit at Phu Tho Provincial Obstetrics and Pediatrics Hospital between January 2024 and September 2025.

- Inclusion criteria: preterm neonates with low birth weight (< 1,500 g); neonates requiring prolonged parenteral nutrition (>5–7 days), infusion of hyperosmolar solutions, vasoactive agents, or long-term antibiotic therapy; and neonates with surgical conditions (e.g., necrotizing enterocolitis) or severe respiratory failure or critical congenital heart disease.

- Exclusion criteria: neonates with incomplete medical records lacking key study variables or whose parents or legal guardians declined participation in the study.

2.2. Study design and methods

Study design: A cross-sectional descriptive study with analytical components.

Sample size and sampling method: Convenience sampling was applied, including all neonates who met the inclusion criteria during the study period. A total of 120 PICC placement procedures performed in 116 neonates were included in the analysis.

Sampling procedure: Data were collected from neonates who were indicated for and underwent PICC placement at the unit between January 2024 and September 2025.

Data collection tools: Data were obtained from the electronic medical records and a standardized data collection form, which included demographic information, clinical characteristics, laboratory parameters, and daily catheter monitoring data.

PICC placement procedure (independent variables): The procedure was performed by specialized neonatal nurses in accordance with the aseptic technique guidelines issued by the Ministry of Health. Polyurethane or silicone catheters (1.9 Fr or 2.0 Fr) were used. Catheter tip position was confirmed by contrast-enhanced radiography immediately after the procedure.

Outcome measures (dependent variables):

+ Success rate: successful catheter insertion into the venous system with the catheter tip positioned in a central vein;

+ Complications: incidence of central line–associated bloodstream infection (CLABSI), catheter occlusion, catheter malposition, or pleural/pericardial effusion;

+ Catheter dwell time: number of days the catheter remained functional until removal.

2.3. Data management and statistical analysis

Data were entered using EpiData software and analyzed with medical statistical software (SPSS or Stata).

Descriptive statistics—including frequencies, percentages, means, and standard deviations—were used to summarize the characteristics of the study sample.

The χ^2 (Chi-square) test or Fisher's exact test was applied to assess associations between potential factors (gestational age, birth weight, insertion site, etc.) and procedural outcomes as well as complications. Associations were considered statistically significant at a p-value of < 0.05.

2.4. Ethical considerations

The study was reviewed and approved by the Ethics and Scientific Committee of Phu Tho Provincial Obstetrics and Pediatrics Hospital. All procedures were conducted on a voluntary basis with informed consent obtained from the parents or legal guardians after they had been fully informed about the study objectives, potential benefits, and possible risks.

All personal information of the neonates was anonymized and kept strictly confidential, and the data were used solely for scientific research purposes. The study did not incur any additional costs for participants and did not interfere with or alter the standard clinical care provided to the patients.

3. RESULTS

Table 1. General characteristics of neonates undergoing PICC placement (n = 120)

| Characteristics | | Number (n) | Percentage (%) |
|----------------------------|------------------|------------|----------------|
| Sex | Male | 65 | 54.2 |
| | Female | 55 | 45.8 |
| Gestational age categories | < 28 weeks | 33 | 27.5 |
| | 28 to < 32 weeks | 59 | 49.2 |
| | 32 to < 37 weeks | 27 | 22.5 |
| | ≥ 37 weeks | 1 | 0.8 |
| Birth weight categories | < 1000g | 44 | 36.7 |
| | 1000 to < 1500g | 45 | 37.5 |
| | ≥ 1500g | 31 | 25.8 |

The study population showed a relatively balanced sex distribution, with males accounting for 54.2% and females for 45.8%. Regarding gestational age, neonates born at 28 to < 32 weeks constituted the largest proportion (49.2%), followed by those born at < 28 weeks (27.5%) and 32 to < 37 weeks (22.5%), while term infants (≥ 37 weeks) accounted for a very small proportion (0.8%). Birth weight stratification revealed that neonates weighing 1,000 to < 1,500 g represented the highest proportion (37.5%), followed closely by those weighing < 1,000 g (36.7%), and those weighing ≥ 1,500 g (25.8%). These findings indicate that the majority of the study

population consisted of preterm and low-birth-weight neonates.

Table 2. Comorbidities and indications for PICC placement (n = 120)

| Characteristics | | Number (n) | Percentage (%) |
|---|---------------------------|------------|----------------|
| Underlying conditions at the time of PICC placement | Respiratory disorders | 117 | 97.5 |
| | Prematurity | 105 | 87.5 |
| | Neonatal sepsis | 57 | 47.5 |
| | ≥ 3 concurrent conditions | 96 | 80.0 |
| Indications for PICC placement | Therapeutic purposes | 115 | 95.8 |
| | Nutritional support | 113 | 94.2 |
| | Resuscitation | 9 | 7.5 |

Respiratory disorders and prematurity were the most common conditions at the time of PICC placement. The majority of neonates presented with multiple comorbidities, with 80.0% having three or more concurrent conditions, reflecting a high severity of illness. PICC placement was primarily indicated for therapeutic management and prolonged nutritional support.

Table 3. PICC insertion characteristics and catheter tip position (n = 120)

| Technical parameters | | Number (n) | Percentage (%) |
|---|---|------------|----------------|
| Number of PICC insertion attempts | First attempt | 116 | 96.7 |
| | Second attempt | 4 | 3.3 |
| Selected venous access sites for PICC placement | Internal jugular vein | 1 | 0.8 |
| | Cephalic vein | 1 | 0.8 |
| | Popliteal vein or above the popliteal fossa | 9 | 7.5 |
| | Ankle vein | 1 | 0.8 |
| | Dorsal hand vein | 25 | 20.8 |
| | Axillary vein | 8 | 6.7 |
| | Basilic vein | 11 | 9.2 |
| | Brachial vein | 64 | 53.3 |
| Catheter tip position on radiography | Correct central position | 97 | 80.8 |
| | Peripheral or malpositioned tip | 23 | 19.2 |

The results demonstrated that PICC placement was predominantly successful on the first attempt, with a very high success rate (96.7%), whereas the proportion of cases requiring a second attempt was low (3.3%). Regarding venous access selection, the brachial vein was the most frequently used site (53.3%), followed by the dorsal hand vein (20.8%) and the basilic vein (9.2%). Other sites—including the axillary vein, popliteal region, internal jugular vein, cephalic vein, and ankle vein—were used less frequently.

Radiographic assessment of catheter tip position showed that 80.8% of catheters were correctly positioned in a central vein; however, 19.2% had peripheral or malpositioned tips, indicating the need for close monitoring and potential adjustment to ensure optimal efficacy and safety of treatment.

Table 4. PICC-related complications (n = 120)

| Complications | Number (n) | Percentage (%) |
|-----------------------------------|------------|----------------|
| CLABSI | 14 | 11.7 |
| Extravasation with local swelling | 12 | 10.0 |
| Catheter occlusion | 5 | 4.2 |
| Catheter rupture | 2 | 1.7 |
| Total complications | 33 | 27.5 |

The overall rate of PICC-related complications was 27.5%, with central line-associated bloodstream infection (CLABSI) being the most frequent complication.

Table 5. Summary of associations between CLABSI and related factors

| Characteristics | | CLABSI | | p |
|------------------------------------|----------------------|------------|------------|-------|
| | | Yes | No | |
| Gestational age (weeks, mean ± SD) | | 23.8 ± 1.6 | 29.5 ± 2.8 | 0.026 |
| Catheter tip position | Non-central (n = 23) | 6 (26.1%) | 17 (73.9%) | 0.017 |
| | Central (n = 97) | 8 (8.2%) | 89 (91.8%) | |
| Mean birth weight (g) | | 1067 | 1209 | 0.021 |
| Mean catheter dwell time (days) | | 19.35 | 18.1 | 0.63 |

Table 5 demonstrates that CLABSI was significantly associated with gestational age, birth weight, and catheter tip position ($p < 0.05$). Neonates with lower gestational age and lower birth weight, as well as those with non-central catheter tip placement, had a higher risk of developing CLABSI. In contrast, catheter dwell time was not significantly associated with CLABSI ($p > 0.05$).

4. DISCUSSION

This study demonstrated that PICC placement in neonates, particularly among preterm and extremely preterm infants, achieved a high success rate (96.7%). This finding is consistent with, and in some cases higher than, those reported in previously published international studies, thereby confirming the safety and effectiveness of PICC placement in neonatal intensive care settings [1–2].

The study population predominantly consisted of preterm neonates with relatively low mean gestational age and birth weight compared with cohorts reported in some international studies. This reflects the characteristics of a provincial-level neonatal intensive care unit that receives a high proportion of critically ill referrals from lower-level facilities. Similar observations have been reported by Sengupta et al. [5] and Yu et al. [6], who identified low gestational age and low birth weight as key factors influencing PICC placement outcomes and catheter maintenance.

In the present study, PICCs were inserted relatively early after birth and maintained for a comparatively long duration, meeting the requirements for prolonged intravenous therapy and parenteral nutrition in preterm infants. These findings are in agreement with previous reports indicating that catheter dwell time is primarily determined by clinical indications and disease severity rather than the insertion technique itself [5,7].

From a technical perspective, the basilic vein and other upper extremity veins were the most commonly selected access sites because of their anatomical advantages and procedural feasibility, which contribute to higher insertion success rates and a reduced number of needle punctures. This finding is consistent with previous studies describing PICC techniques in pediatric and neonatal populations [2]. The proportion of catheters with correct central tip positioning immediately after insertion exceeded 80% and increased to nearly 97% following corrective interventions, highlighting the critical role of post-insertion verification and adjustment of catheter tip position in clinical practice.

The overall rate of PICC-related complications in this study was 27.5%, including both infectious and non-infectious complications. CLABSI accounted for 11.7% of cases, with an incidence density of 6.3 per 1,000 catheter-days. These results fall within the range reported in international studies and indicate that CLABSI remains a significant concern in neonates with PICCs [4,7].

Analysis of associated factors demonstrated that non-central catheter tip positioning increased the risk of complications, particularly non-infectious events. In addition, very preterm and extremely preterm neonates were at a higher risk of complications, which is consistent with their physiological immaturity and underdeveloped immune function. These findings are in line with those

reported by Sengupta et al. [5] and Yu et al. [6], who emphasized the roles of gestational age, birth weight, and catheter tip position in the development of PICC-related complications in neonates.

5. CONCLUSION

PICC placement in neonates, particularly in preterm infants, demonstrates a high success rate and effectively meets the requirements for prolonged therapy, resuscitation, and parenteral nutrition. Catheter tip position plays a crucial role in minimizing complications, with non-central tip placement being associated with an increased risk of non-infectious complications.

Catheter-related bloodstream infection remains a notable complication, occurring more frequently in neonates with lower gestational age and birth weight, underscoring the importance of appropriate indication, precise insertion technique, and strict adherence to infection prevention and control measures.

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