ORIGINAL ARTICLE

# Outcome of Neonatal Peripherally Inserted Central Venous Catheterization in Neonatal Intensive Care Unit

Rynnara Porncharoennsub, MD[1], Pichada Saengrat, MD[1]

[1] Department of Pediatric, Faculty of Medicine, Navamindradhiraj University, Bangkok, Thailand

**Background:** Peripherally inserted central venous catheters (PICCs) are essential in caring for sick or premature newborns. They are often used for neonatal vascular access and provide life-sustaining parenteral nutrition and medication.

**Objective:** To determine PICC complication rates and risk factors for PICCs complications in the neonatal intensive care unit (NICU).

**Materials and Methods:** This was a retrospective study of 182 critically-ill neonates who received PICCs in the NICU between 2018 and 2023. The outcomes studied included non-elective PICC removal, occlusion, leakage, and catheter-related sepsis.

**Results:** The mean gestational age (GA) of neonates in whom PICCs were placed was 29.2±3.44 weeks, and the mean birth weight (BW) was 1,155.8±189 grams. The average length of stay was 17.5±5.2 days. The total number of complications was 33%; common complications were occlusion (13.7%), leakage (11.5%), non-elective PICC removal (6%), and central line-associated bloodstream infection (CLABSI) (2.7%). Factors associated with complications were upper extremity catheterization and length of stay greater than 14 days.

**Conclusion:** Complications occurred in about one-third of PICCs. Incidence rate of complications was 15.3 per 1,000 catheter days. The results informed the development of guidelines and management of PICCs in the neonatal intensive care unit, particularly in neonates requiring PICCs for more than 14 days and in PICC upper extremities PICC insertion.

**Keywords:** Peripherally inserted central venous catheters; Newborn; Complication; Risk factor

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Newborns treated in the neonatal intensive care unit (NICU) are critically ill, mostly premature infants who require prolonged enteral nutrition and medications[1]. Intravenous administration of fluids via peripheral inserted central venous catheters (PICCs) is now widely used. It is a valuable contribution to treating sick neonates, especially infants with very low birth weight (VLBW)[2,3]. PICCs are made of soft silicone or polyurethane by inserting the catheter through the venous catheter into the tip of the baby's extremities, apart from cannulation of the umbilical vein.

Although the insertion of a PICCs has many advantages, the presence of an indwelling PICC also brings complications, such as infection, atherosclerosis, inflammation, extravasation, bleeding, thrombosis, pleural and pericardial effusions, pneumothorax, catheter obstruction and catheter-related sepsis[4-6]. In a previous study in Thailand, PICCs complications occurred in 10.9% of cases. The incidence rate of complications was 7.1 per 1,000 catheter days, and the risk factor for complications was neonates weighing more than 1,500 grams[7].

Careful placement of PICCs is extremely important to prevent complications, as PICCs are very small and can easily become loose due to newborn movements or various interventions. The results of the study can improve the quality of neonatal care. This research aims to identify complications of PICCs placement in sick newborn and specific risk factors associated complications in NICU setting.

## Materials and Methods

For the present study, the medical records of 182 infants who were retrospectively admitted to the NICU of the Department of Pediatrics, Faculty of Medicine, Navamindradhiraj University, between January 1, 2018, and December 31, 2023, were analyzed. Critically-ill Infants who received a PICC for the first time to maintain

**Correspondence to:**

Saengrat P.

Department of Pediatric, Faculty of Medicine, Navamindradhiraj University, 681 Samsen Road, Dusit, Bangkok 10300, Thailand.

**Phone:** +66-84-1633577

**Email:** pichada@nmu.ac.th

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intravenous hydration in NICU were included in the study so, there was one PICC per patient. Exclusion criteria for cases were infants who was transfer to another hospital and died before PICC removal. Data included gestational age (GA), birth weight (BW), sex, site of catheter placement, reason for catheter removal, and duration of catheter use. Catheter-related complications such as catheter occlusion, leakage, extravasation, non-elective PICC removal (unintentional dislodgement or removal of the catheter), and central line-associated bloodstream infection (CLABSI) were recorded. CLABSI was defined as clinical deterioration and positive blood culture with the same microorganism at the catheter tip and microbiologic absence of another source of infection[8]. The University Institutional Review Board approved the conduct of this study) (No. 056/65E).

### Statistical analysis

The Statistical Package for Social Sciences for Windows (SPSS version 28.0, SPSS Inc. Chicago, IL, USA) was used to process the data and statistics. Data were expressed as mean ± standard deviation (SD), rates, and percentages. Data were analyzed using descriptive statistics, incidence rates, and binary logistic regression. Multivariate logistic regression was used to identify complications associated with risk factors. In this study, sample size determination utilizes the calculation from the formula for estimating an infinite population proportions, based on population proportion data cited from a study in Thailand by Thongsawang S, et al.[7]. The study found a complication rates of 10.96%, and sets the type I error rate at 0.05. The sample size and power of the analysis were calculated for the study with a power of 95%, and a value of $p<0.05$ was assumed to be significant.

## Results

Table 1 summarizes the clinical characteristics of neonates with PICCs. 10 neonates were excluded due to transfer to another hospital, died and missing data. A total of 182 neonates were included in the present study. 53% of the neonates were male and 47% were female. The mean gestational age was 29.2±3.44 weeks, and the mean birth weight was 1,155.8±489 grams. Most infants had a gestational age of less than 32 weeks and a birth weight of less than 1,500 grams, corresponding to 81% of the population. 61.6% of newborns had a PICCs placement lasting longer than 14 days. The average duration was 17.5±5.2 days. Regarding the choice of PICC size, size 1 French was predominantly used in 177 cases (97%), and in 157 cases (86%), the upper extremity was chosen as the insertion site.

The reasons for removal of the PICCs were the completion of intravenous therapy in 120 cases (65.9%), occlusion in 25 cases (13.7%), fluid leakage in 21 cases (11.5%), and non-elective PICC removal in 11 cases (6%). CLABSI was detected in 5 patients (2.7%), coagulase-negative Staphylococcus epidermidis in 4 patients, and Staphylococcus capitis in one patient (Table 2). The total number of complications was 30%. The incidence rate of

**Table 1.** Baseline clinical characteristics

| Baseline characteristics | Number (n=182) | Percentage (%) | Mean ± SD |
|---|---|---|---|
| Sex | | | |
| Male | 97 | 53.3 | |
| Female | 85 | 46.7 | |
| GA, weeks | | | 29.2±3.44 |
| <32 | 136 | 74.7 | |
| ≥32 | 46 | 25.3 | |
| BW, grams | | | 1,155.8±189 |
| <1,500 | 148 | 81.3 | |
| ≥1,500 | 34 | 18.7 | |
| Duration of PICCs, days | | | 17.5±5.2 |
| <14 | 70 | 38.4 | |
| ≥14 | 112 | 61.6 | |
| Size of PICC | | | |
| 1-French | 177 | 97.3 | |
| 2-French | 5 | 2.7 | |
| Location of PICCs | | | |
| Upper extremity | 157 | 86.3 | |
| Lower extremity | 25 | 13.7 | |

PICCs=peripherally inserted central catheters; GA=gestational age; BW=birth weight

**Table 2.** Reason for removal of PICCs and complications

| Reason for removal of PICCs | Number (n=182) | Percentage (%) |
|---|---|---|
| Reason for removal of PICCs | | |
| Completion of intravenous therapy | 120 | 65.9 |
| Occlusion | 25 | 13.7 |
| Leakage | 21 | 11.5 |
| Non elective catheter removal | 11 | 6.0 |
| CRABSI | 5 | 2.7 |

PICCs=peripherally inserted central catheters; CRABSI=central line associated bloodstream infections

complications was 15.3 per 1,000 catheter days.

When analyzing the individual clinical characteristics related to the complications, leakage was found to be related to upper extremity PICC placement and dwell time of more than 14 days, occlusion was related to upper extremity PICC placement and non-elective catheter removal with general health of less than 32 weeks and body weight of less than 1,500 grams with statistical significance ($p<0.05$) (Table 3). In addition, multiple logistic regression revealed that upper extremity PICC placement and PICC dwell time of more than 14 days were significant factors for complications (adjusted OR 1.52, p=0.042, adjusted OR 1.98, p=0.01 respectively (Table 4).

## Discussion

PICCs are widely used in sick newborns, especially premature infants, to provide adequate long-term nutrition in place of a peripheral vein. In previous studies, the average duration of PICCs in preterm infants was reported to be 9to 37 days[3-10]. In the present study, the mean duration was 17.5 days. As in the previous studies[4-9], 65.9% of catheters were electively removed in the present study. Risk factors for complications from peripheral central catheters in neonates revealed that, as in the present study, 33% of complications due to PICC placement occurred in the upper limbs, more than in the lower limbs[2].

Complications related to PICCs have been reported in several studies, mainly mechanical complications such as occlusion, leakage, accidental catheter removal, and phlebitis[3-11]. In the present study, occlusion was the most common complication, as in previous studies, because the catheter was tiny (1-French), but phlebitis was not reported in this study. CLABSI was associated with prolonged dwell time of PICCs[9-15]. Since only 2.7% of CLABSI occurred in the present study, no factors were associated with CLABSI. All infants diagnosed with CLABSI were highly preterm. Overall, there were 15.3 complications per 1,000 days with PICCs in the present study. This result shows more complications than at Chiangmai University Medical School in Thailand (7.1 times per 1,000 days)[7] and that the complication rate was only 10% because our study had a population 2.5 times larger than the previous study. However, the latest study in 2022 found a complication rates from PICCs insertion of only 12.13%, which was conducted specifically in infants weighing less than 1,500 grams. This differs from this study, which examined all infants treated in the NICU[14]. This study found no cases of phlebitis, possibly due to the quality of care at our center, which includes a protocol for PICC care and regular wound care.

Risk factors associated with complications include upper extremity insertion due to movement and occasional placement directly into the antecubital vein, a flexion point that can be easily occluded. The results of the latest study in 2022 differ from this study by suggesting a preference for inserting PICCs in the upper extremities, however meta-analysis showed no clear evidence on this, which demonstrated that neonatal PICCs in the upper extremity were more inclined to cause malposition but had a lower risk of thrombosis than in the lower extremity[15]. The present study found that the insertion of PICCs in the lower extremity was relatively low (13.7%) compared to upper extremity insertions. This finding suggests caution in interpreting and applying it to clinical practice. Prolonged insertion for more than 14 days increases the risk of complications, as in previous studies[8-13].

There are some limitations to our study. First, the present study only collected data on first-time PICC insertion. Second, data collection was limited to the NICU. Another study compared the incidence of complications related to insertion failure between the traditional versus ultrasound-guided methods. Third, data on who performed the procedure was not collected. Knowledge of the prevalence of complications resulting from using PICC is essential for clinical practice in the NICU and may enable the adoption of strategies guidelines to reduce complications.

## Conclusion

Complications occurred in about one-third of PICCs. The most common complications are occlusion and leakage. A PICC indwelling time of more than 14 days and a PICC inserted in the upper extremity caused statistically significant complications. Optimization of catheter care, prevention strategies for PICCs with longer dwell times, and catheters on the upper extremity help to reduce complications.

### What is already known on this topic?

PICCs is extensively used in critical ill neonates and associated with complications such as occlusion, infection, extravasation and malposition.

### What this study adds?

The study found that indwelling time of more than 14

**Table 3.** Univariate analysis of factors affecting PICCs related complications

| Variable | Leakage | | | CRABSI | | | Occlusion | | | Non-elective catheter removal | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OR | 95% CI | p-value | OR | 95% CI | p-value | OR | 95% CI | p-value | OR | 95% CI | p-value |
| Sex | | | | | | | | | | | | |
| Male | 1 | 0.28 to 1.89 | 0.524 | 1 | 0.12 to 4.62 | 0.761 | 1 | 0.30 to 1.72 | 0.469 | 1 | 0.28 to 10.65 | 0.546 |
| Female | 1.31 | | | 1.31 | | | 1.21 | | | 0.58 | | |
| GA, weeks | | | | | | | | | | | | |
| <32 | 1 | 0.65 to 10.83 | 0.817 | 1 | 0.68 to 1.98 | 0.752 | 1 | 0.61 to 4.19 | 0.976 | 1 | 1.18 to 2.10 | <0.001 |
| ≥32 | 0.85 | | | 0.97 | | | 0.77 | | | 1.21 | | |
| Location at extremities | | | | | | | | | | | | |
| Upper | 1 | 1.54 to 2.37 | 0.034 | 1 | 0.43 to 1.49 | 0.057 | 1 | 1.03 to 3.11 | 0.041 | 1 | 0.74 to 1.79 | 0.717 |
| Lower | 0.84 | | | 0.87 | | | 1.37 | | | 1.86 | | |
| Duration, days | | | | | | | | | | | | |
| <14 | 1 | 2.42 to 2.69 | 0.023 | 1 | 0.57 to 1.86 | 0.544 | 1 | 0.66 to 2.97 | 0.578 | 1 | 1.02 to 2.08 | 0.081 |
| ≥14 | 2.33 | | | 0.33 | | | 2.51 | | | 1.97 | | |
| BW, grams | | | | | | | | | | | | |
| <1,500 | 1 | 0.89 to 2.29 | 0.237 | 1 | 0.76 to 2.97 | 0.954 | 1 | 0.82 to 6.41 | 0.883 | 1 | 1.13 to 2.67 | <0.001 |
| ≥1,500 | 0.78 | | | 0.96 | | | 4.34 | | | 1.02 | | |

PICCs=peripherally inserted central catheters; GA=gestational age; BW=birth weight

**Table 4.** Multivariate analysis of selected factors affecting complications

| Factors | Complications (%) | Adjusted OR | 95% CI | p-value |
|---|---|---|---|---|
| Location | | | | |
| Upper extremity | 1.86 | 1.52 | 1.34 to 1.86 | 0.042 |
| Lower extremity | 0.25 | 0.91 | 1.05 to 1.22 | |
| Duration, days | | | | |
| <14 | 0.88 | 0.71 | 0.88 to 1.23 | 0.010 |
| ≥14 | 3.14 | 1.98 | 1.81 to 2.17 | |

days and inserted in the upper extremity of PICCs might be more inclined complication rates.


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## Conflicts of interest

The authors declare no conflict of interest.

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