

Experience with peripherally inserted central catheters in very low birth weight neonates: Indications, complications, and clinical outcomes

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ABSTRACT

Objective: Vascular access is a critical factor in the monitoring and treatment of neonates requiring intensive care. In this context, peripherally inserted central catheters (PICCs) are one of the primary methods for safely and for extended periods in neonates, compared to traditional central vascular access routes. This study aimed to evaluate the indications and complications of PICC placement and to raise awareness of the development and implementation of protocols to prevent complications.

Materials and Methods: In this study, after obtaining approval from the Ethics Committee, the indications, compositions, and clinical outcomes of patients born at Mersin City and Education Hospital between 01.01.2024-01.10.2025, weighing ≤ 1500 g and those who had peripheral central catheters left in place, were evaluated retrospectively.

Results: A total of 89 patients were included in the study. Forty-nine cases were male (44.9 %). Forty-nine of the cases were 28 weeks of gestation or less. Thirty-three cases were inserted due to prematurity, forty-two due to feeding difficulties, and three due to pre/post-operative complications. The median PICC placement day was 5 d (4-12.5), and the median weight was 1020 g (780-1310). Nineteen cases developed complications related to PICCs. Among the complications, phlebitis was the most common (47.4%). Four patients required catheter removal due to infection. Nine patients (10.1%) died. Eighty patients (89.9%) were discharged after recovery.

Conclusion: Peripherally inserted central catheters play a crucial role in neonatal intensive care by providing reliable, long-term venous access in neonates. When used with appropriate indications, strict aseptic technique, and standardized care protocols, they provide a healthy and safe vascular pathway for newborns with low complication and infection rates. A specialized team approach, guided by protocols, can enhance the quality of care in the neonatal intensive care unit.

Keywords: Mortality, newborn, PICC, NICU, sepsis

Introduction

Peripherally inserted central venous catheters (PICCs) are a reliable method of central venous access widely used in neonatal intensive care units for infants requiring prolonged intravenous therapy. Intravenous access is essential for the administration of fluids, medications, and parenteral nutrition in many hospitalized patients. These catheters can be inserted at the bedside without general anesthesia and may remain in place for extended periods. By providing safe and durable vascular access, peripherally inserted central catheters play a life-saving role in the management of neonates (1, 2).

A peripherally placed central catheter can be inserted into a deep vein of the upper or lower extremities. Scalp veins are also a safe and alternative site for PICC placement. Numerous veins, including the cephalic, basilic, saphenous, or superficial temporal vein, are suitable for PICC cannulation (3).

Placement of a PICC in an infant prevents repeated venous punctures, thereby minimizing pain and discomfort. By reducing the need for repeated invasive procedures, it may also decrease the risk of infection and provide prolonged, reliable vascular access. In addition, PICCs help preserve peripheral veins and, by lowering infection risk, may contribute to shorter hospital stays and reduced hospitalization costs (4).

Although PICCs offer significant advantages in clinical practice, certain complications may occur related to their insertion and use. The most common complications include catheter-related infections, phlebitis, catheter fracture, leakage, rupture, and abnormal catheter positioning or migration (5, 6).

The aim of this study was to investigate the clinical characteristics, incidence of infections, and outcomes of very low birth weight neonates admitted to our neonatal intensive care unit who required peripherally inserted central catheter placement during the postnatal period.

Materials and Methods

The study was designed as a retrospective analysis of patients born at ≤ 1500 g and admitted to the neonatal intensive care unit at Mersin City and Education Hospital between 01.01.2024-01.10.2025. Data related to peripherally inserted central catheters were collected and recorded accordingly.

The following data were retrospectively retrieved from the hospital database: gestational age, birth weight, mode of delivery, gender, day of peripherally inserted central catheter placement, body weight on the day of catheter insertion, anatomical site of insertion, number of insertion attempts, catheter size, duration of catheterization, presence of catheter-related complications, occurrence of catheter-related infection and the isolated pathogen, as well as patient outcome data.

Peripherally inserted central catheter placement procedure

In this study, all PICCs were performed by a neonatologist and three PICC-specialized nurses who had received both theoretical and hands-on training. VYGON® GmbH & Co. KG 1F (24G) and 2F (28G) catheters were used for catheter placement. The basilic vein and median cubital vein in the antecubital region were selected as the primary insertion sites.

PICC was carried out at the bedside within the neonatal intensive care unit under laminar airflow conditions, and all procedures were performed in accordance with established standard protocols. Following catheterization, the catheter tip position was confirmed by radiographic (X-ray) evaluation. For neonatal blood culture sampling, BACT/ALERT® pediatric blood culture bottles were used. Blood samples of no less than 1 mL were obtained, and the VITEK® 2 (bioMérieux) automated culture system was utilized for microbiological analysis of neonatal specimens.

In this study, clinical sepsis was defined as the presence of general clinical deterioration, apnea, tachycardia, bradycardia, and elevated acute-phase reactants, or the isolation of a causative microorganism from sterile body fluids. Culture-proven bloodstream infection was defined as the growth of a pathogenic organism in blood culture. Colonization was defined as microbial growth without accompanying clinical signs of infection (7). Catheter-related bloodstream infection (CRBSI) was defined as the isolation of the same microorganism from both peripheral blood and the tip of the PICCs within 48 hours after catheter placement (7).

Statistical analysis

Data were analyzed using IBM SPSS version 26.0 (IBM SPSS Statistics for Windows, IBM Corp., Armonk, NY)

software. Descriptive statistics were expressed as numbers, percentages (%), median, mean, and standard deviation.

Results

A total of 89 patients were included in the study. Infants with a birth weight above 1500 g and those outside the specified study period were excluded. Forty-nine patients were female (55.1%), and 40 were male (44.9%). Forty-nine infants were born at or below 28 weeks of gestation. Peripherally inserted central catheters were placed in 33 infants due to prematurity, in 42 due to feeding intolerance, in three for pre- or postoperative management, in seven for sepsis treatment, and in four because of difficult vascular access. Patients with difficult vascular access were those who had not yet transitioned to full enteral nutrition without nutritional intolerance. The median day of PICCs placement was 5 days (4-12.5), and the median body weight at the time of placement was 1020 g (780-1310). A 2F catheter was inserted in three patients, whereas a 1F catheter was used in all other cases. Successful catheterization was achieved on the first attempt in 69 patients; 18 required two attempts, one required three attempts, and one required four attempts. In 53 cases (59.6%), the catheter was inserted via the left antecubital region.

The PICCs remained in place for a median dwell time of 16 (10-25) days. While 76 patients required only a single catheter placement, 10 patients required two insertions at different time points, and three patients required a total of three PICCs placements.

Complications associated with PICC were observed in 19 cases, with phlebitis being the most common complication among these 19 cases (47.4%). In four patients, the catheter had to be removed due to infection. Two cases presented with clinical sepsis, and *Staphylococcus aureus* was isolated in two cases.

When infection rates were evaluated, only two patients (2.2%) had culture-proven bloodstream infections. No catheter-related bloodstream infections (CRBSIs) were identified in our cohort.

The mean length of hospital stay was 60 ± 28.5 days. Nine patients (10.1%) died, while 80 patients (89.9%) were discharged in good health. Detailed patient data are presented in Table I.

Discussion

The use of peripherally inserted central catheters has increased worldwide in parallel with advances in neonatal care. Owing to their ability to provide secure vascular access, allow prolonged use, and maintain a relatively low risk of infection, PICCs are increasingly preferred over umbilical venous catheters in current practice.

Particularly in preterm and very low birth weight infants, as well as in cases of feeding intolerance, necrotizing enterocolitis, sepsis, and in preoperative or postoperative management, the use of PICCs has steadily expanded. By providing reliable and relatively comfortable vascular access, PICCs have established a crucial role in modern neonatal intensive care units.

Table 1: Demographic and clinical characteristics of the study population

Variables	Values
Gestational age (weeks)*	28.3±1.2
Gender†	
Male	40 (44.9)
Female	49 (55.1)
Birth weight (g)‡	1080 (680-1420)
Weight at PICC placement‡	1020 (780-1310)
Day of PICC placement‡	5 (4-12.5)
PICC size†	
1F (28G)	86 (96.6)
2F (24G)	3 (3.4)
Clinical diagnosis†	
Prematurity	77 (86.5)
IUGR	7 (7.9)
NEC	2 (2.2)
Gastroschisis	2 (2.2)
Intestinal Atresias	1 (1.1)
Indication for PICC placement†	
Prematurity	33 (37)
Nutritional deficiency	42 (47.2)
Pre/post-operative	3 (3.4)
Infection treatment	7 (7.9)
Difficult vascular access	4 (4.5)
Number of insertion attempts†	
1	69 (77.5)
2 or more	20 (22.5)
Number of PICC placements per patient†	
1	76 (85.4)
2	10 (11.2)
3 or more	3 (3.4)
PICC insertion site†	
Right antecubital	34 (38.2)
Left antecubital	53 (59.6)
Upper right-hand	2 (2.2)
Catheter dwell time (days)‡	16 (10-25)
Catheter complications†	
None	70 (78.6)
Phlebitis (swelling, redness)	9 (10.1)
Leaking	5 (5.6)
Catheter rupture	1 (1.1)
Occlusion	4 (4.5)
Systemic infection†	
Clinical sepsis	2 (2.2)
Culture-positive sepsis	2 (2.2)
Duration of hospitalization (days)‡	60 (45-78.5)
Outcome†	
Discharge	80 (89.9)
Exitus	9 (10.1)

*: mean±SD, †: n(%), ‡: median (IQR), **IUGR**: Intrauterine growth restriction, **NEC**: Necrotizing enterocolitis

Our NICU is a tertiary-level neonatal intensive care unit with a capacity of 66 beds and an average annual admission volume of approximately 2000 patients. In our center, catheter insertions are performed by a neonatologist and three nurses who have completed formal training and certification in PICC placement.

Taylor T. et al.(8) reported that, following the establishment of a dedicated PICC team in the neonatal intensive care unit, the incidence of catheter-related bloodstream infections was reduced by nearly half among extremely low birth weight infants requiring long-term central venous access. The fact

that only two of our patients developed culture-positive infections may be attributed to the placement of PICCs by trained and experienced healthcare professionals, with strict adherence to hygienic and aseptic conditions. In addition, regular catheter care and dressing changes performed by the same dedicated team may have contributed to the low rate of infection observed (9).

Standardization of PICC line is essential and constitutes a prerequisite for improving catheter-related bloodstream infection rates. The use of a unified approach and language in catheter care by the team performing the insertion, together with their experience and expertise, may have contributed to the absence of catheter-related infections in our patients (10).

There are no definitive data regarding the optimal duration of PICCs placement in patients hospitalized in the neonatal intensive care unit. Several studies have suggested that the risk of catheter-related complications increases as the catheter dwell time lengthens. In particular, the risk of catheter-related infection rises with increasing PICC duration. A study conducted in neonates reported that for PICCs remaining in place for more than 35 days, the risk of catheter-related infection increased by 33% for each additional day the catheter remained in situ (1).

The anatomical characteristics of neonates allow access to multiple potential sites for PICCs placement (11). The veins of the upper extremities are longer and narrower than the femoral vein, whereas the femoral vein has a larger diameter and is located more deeply. Theoretically, frequent limb movements may lead to intimal injury and phlebitis, which are more commonly observed in the upper extremities compared to the lower extremities. Therefore, complications such as phlebitis, occlusion, or catheter fracture and breakage may occur more frequently in catheters inserted through the lower extremities (12, 13).

When the timing of peripheral central catheter placement was evaluated, the median insertion day in our study was 5 (4-12.5 d). In our clinical practice, initial vascular access is established via standard methods following admission to the unit, and PICC is performed only when conventional vascular access is no longer feasible.

The rationale for this approach is to ensure adequate thermal and pain control in the newly born neonate and to protect edematous infants—who have not yet achieved sufficient diuresis during the first days of life—from repeated invasive attempts.

The statistically high variability observed in PICCs days may be attributed to repeated PICC requirements, as well as to the presence of patients requiring PICCs for conditions other than prematurity, such as sepsis and preoperative or postoperative management.

Hu Y. et al.(4) reported that a birth weight ≤1500 g, a PICCs dwell time ≥21 days, and PICC via the femoral vein were significant risk factors for catheter-related bloodstream infection in neonates with PICCs.

To prevent PICCs-related bloodstream infections, the necessity of the PICC line should be reviewed on a daily basis, catheter care practices should be optimized, and targeted

infection-prevention strategies should be implemented, particularly for catheters with prolonged dwell times.

In a multicenter study conducted by Milstone et al. (14), which evaluated 4797 PICC lines inserted in a total of 3967 neonates, 149 cases of catheter-related bloodstream infections occurred over 89946 catheter days, corresponding to an incidence rate of 1.66 per 1000 catheter days. The lowest infection rates were observed in catheters with a dwell time of fewer than seven days. In contrast, PICC lines remaining in place for 8–13 days, 14–22 days, and ≥ 23 days were each associated with a significantly higher risk of infection compared to those with a dwell time of ≤ 7 days ($p < 0.050$). The authors further reported that during the first two weeks following PICC placement, the risk of CRBSI increased with each additional day the catheter remained in situ. Moreover, they noted a higher frequency of gram-negative CLABSIs (Central Line-Associated Bloodstream Infections) cases in catheters with a dwell time exceeding 50 days (14).

In our study, although the median catheter dwell time was 16 (10–25) days, no catheter-related bloodstream infections were observed.

In addition to proper PICC and maintenance practices, clinicians should exercise careful judgment regarding catheter retention or removal, taking into account the increased risk of infection associated with prolonged catheter duration. Such measures are essential for reducing catheter-related infection rates and for supporting quality improvement initiatives in the neonatal intensive care unit (15).

In neonates and children, optimization of PICCs and maintenance practices to prevent CLABSIs, as well as the establishment of dedicated catheter teams within each institution, has been supported by previous studies. In our unit, the presence of a specialized catheter insertion and maintenance team has played a pivotal role in the favorable catheter-related outcomes observed (16, 17).

The microorganisms responsible for CLABSIs and bacteremia may vary according to the duration of catheter dwell time. Smith et al. (18) reported that the mean time to the development of gram-positive bacteremia was eight days after catheter insertion, whereas gram-negative bacteremia occurred at a mean of 13.5 days following insertion. Similarly, Sengupta et al. (9) found that coagulase-negative *Staphylococci* (55.6%) were the predominant pathogens during the first two weeks after PICC, while Gram-negative bacteria (58.3%) became the dominant organisms beyond the initial two-week period.

In our study, both isolated microorganisms were *Staphylococcus aureus*. One case occurred in a 1420 g neonate in whom the catheter was inserted on postnatal day eight due to difficult vascular access and remained in place for only four days. The other case involved an infant born at 27 weeks of gestation with a birth weight of 910 g; the catheter was inserted on postnatal day 64 for the treatment of sepsis and was used for 14 days. Similarly, Yan Hu et al. (4) reported *Staphylococcus aureus* (23.92%) as the second most frequently isolated pathogen in their study.

When catheter insertion sites were evaluated, the right and left antecubital veins were the most commonly used sites in our study. In a study assessing the relationship between

catheter insertion site and CLABSI incidence, a higher risk was identified in catheters inserted via the femoral vein (4). Another study published in 2024 evaluated PICC placement sites, ease of use, and complication rates, and concluded that the saphenous vein in the right lower extremity may represent the most suitable site for PICC in neonates (19). Another study reported no significant difference between upper and lower extremity PICC sites with respect to complications requiring catheter removal (20).

In a meta-analysis investigating whether placement of PICCs in neonates via upper versus lower extremity veins differed in terms of ease of use, reduced infection risk, and complication rates, PICC through the lower extremity veins was found to be easier compared with insertion through the upper extremity veins (21).

When the findings of our clinical study are evaluated in conjunction with the existing literature, it should be acknowledged that the selection of the PICCs site in neonates depends on the quality of the infant's available veins, the suitability of the insertion site, and the skill and experience of the practitioner performing the procedure.

When PICC placement and complications are evaluated, it is observed that complications resulting in mortality are encountered (22). None of the nine patients who lost their lives in our study died due to PICC complications.

Limitations

Our study has several notable strengths as well as certain limitations. The single-center design may be considered a methodological limitation; however, given the number of cases and the duration of the study period, the dataset is numerically substantial.

One of the key strengths of our study is that catheter insertions in neonates were performed according to a standardized protocol by the same dedicated team. We believe that the establishment of specialized interventional teams in neonatal care may lead to meaningful improvements in both short- and long-term follow-up and treatment outcomes.

Conclusion

Peripherally inserted central catheters play an important role in neonatal intensive care, particularly in neonates with a birth weight ≤ 1500 g, by providing reliable long-term venous access. When used with appropriate indications, strict aseptic technique, and standardized care protocols, PICC can be performed safely with low complication and infection rates.

Although prolonged catheter dwell time may increase the risk of infection, daily assessment of catheter necessity, adherence to aseptic principles, correct catheter positioning, and proper maintenance can help reduce adverse outcomes. The choice of insertion site should be individualized based on vascular access, the infant's clinical condition, and the operator's experience.

The presence of an experienced and dedicated catheter team plays a key role in reducing catheter-related complications. Therefore, a protocol-based and specialized team approach

may improve the quality of care in the neonatal intensive care unit.

Ethics committee approval

This study was conducted in accordance with the Helsinki Declaration Principles. The study was approved by Mersin City Hospital (20/10/2025, reference number: 2025/05).

Contribution of the authors

MDT: Primarily responsible for protocol development, patient screening, registration, outcome assessment, preliminary data analysis, and manuscript writing. He planned the study design and supervised its implementation. HS, MY, MA: Responsible for developing the protocol and evaluating the results. ESY,SA,BOÖÖ: performed protocol development, patient screening, outcome assessment and statistical analysis, and was primarily responsible for the registration procedures.

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Conflict of interest

The authors declare that there is no conflict of interest.

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