

<https://doi.org/10.33472/AFJBS.6.Si2.2024.427-434>



African Journal of Biological Sciences

Journal homepage: <http://www.afjbs.com>



Research Paper

Open Access

Exploring Complications and Outcomes of Peripherally Inserted Central Venous Catheters (PICC) in Neonates: A Tertiary Care Unit Study

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Article History

Volume 6, Issue Si2, 2024

Received: 26 Feb 2024

Accepted : 02 Apr 2024

doi: 10.33472/AFJBS.6.Si2.2024.427-434

Abstract

Background: Peripherally Inserted Central Venous Catheters (PICCs) are commonly used in neonatal intensive care units (NICUs) for the administration of intravenous fluids and medications. However, PICC placement is not without risks, and complications can arise, affecting neonatal outcomes.

Objective: This study aimed to investigate the complications associated with PICC use in neonates admitted to a tertiary care NICU and evaluate the outcomes of these complications.

Methods: A retrospective analysis of neonates with PICC lines inserted at the NICU of a tertiary care center was conducted. Data on PICC insertion, complications, and outcomes were collected and analyzed.

Results: The study included 47 neonates with PICC lines. The most common indications for PICC insertion were IV infusion in preterm neonates (76.5%) and difficult venous access (12.8%). Complications observed included catheter-associated bloodstream infections (14.9%), sepsis (4.3%), and necrotizing enterocolitis (6.3%). Despite complications, 83.1% of the neonates were discharged, while 8.5% expired, and 4.2% were referred to higher centers.

Conclusion: PICC use in neonates is associated with various complications, including bloodstream infections and sepsis. However, most neonates with PICCs were discharged successfully, highlighting the importance of vigilant monitoring and prompt management of complications to improve outcomes.

Keywords: Peripherally Inserted Central Venous Catheter, Neonates, Complications, PICC line, NICU, Tertiary Care Center

Introduction:

In neonatal care, Peripherally Inserted Central Venous Catheters (PICCs) serve as lifelines, offering vital intravenous access for administering medications, parenteral nutrition, and fluids to neonates in critical conditions. The delicate nature of neonatal physiology demands meticulous attention to detail and the adoption of the safest possible practices in medical interventions. However, despite their indispensability, PICCs are not without risks. Complications associated with their use, ranging from infections to thrombosis, pose significant challenges in neonatal care settings [1].

PICCs have become a mainstay in neonatal intensive care units (NICUs) due to their versatility and ease of use [2]. These catheters, typically inserted into a peripheral vein with the tip terminating in a central vein, offer a conduit for administering medications and nutrients while minimizing the need for frequent venipunctures. While the benefits of PICC use in neonates are evident, their insertion and maintenance present inherent risks, particularly in this vulnerable population [3].

Neonates, with their underdeveloped immune systems and fragile vascular structures, are predisposed to complications associated with invasive procedures like PICC insertions [4]. Infections stemming from catheter-related bloodstream infections (CRBSIs) can lead to sepsis, a grave concern in neonatal medicine. Furthermore, thrombotic events, though less frequent, can result in vessel occlusion, compromising vascular access and necessitating premature catheter removal [5].

Despite advancements in catheter design and insertion techniques, complications associated with PICCs in neonates persist [6]. These complications not only jeopardize patient outcomes but also contribute to healthcare costs and prolong hospital stays. Therefore, a comprehensive understanding of the complications and outcomes associated with PICCs in neonates is crucial for optimizing patient care and minimizing adverse events [7-10].

This study aims to address this critical gap by conducting a thorough examination of the complications and outcomes of PICCs in neonates admitted to a tertiary care unit. By elucidating the incidence of complications and evaluating associated outcomes, we seek to inform clinical practice guidelines and improve the safety and efficacy of PICC use in this vulnerable patient population.

Materials and Methods:

In this study, conducted over a period of 18 months at a tertiary care center's Neonatal Intensive Care Unit (NICU), we aimed to investigate the utilization, complications, and outcomes of Peripherally Inserted Central Venous Catheters (PICCs) in neonates. Neonates admitted to the NICU with PICC lines inserted were included in the study. The decision to use PICCs was typically made for neonates with difficult venous access, those requiring prolonged courses of Total Parenteral Nutrition (TPN) or antibiotics, or those needing hyperosmolar solutions such as concentrated glucose.

Our data collection process involved meticulous observation and documentation of various parameters related to PICC line insertion and management. This included demographic information such as gestational age and birth weight, as well as clinical details like the

indication for insertion, postnatal day of insertion and removal, site of insertion, ease of insertion, duration of catheterization, complications encountered, and reasons for removal.

To ensure accuracy and reliability, laboratory investigations were conducted as part of the study protocol. These included routine tests such as Complete Blood Count (CBC), C-reactive protein estimation, and blood culture. Additionally, PICC line tip cultures were performed to identify any associated infections and determine appropriate treatment strategies.

The procedure for PICC line insertion followed a standardized protocol involving careful patient positioning, meticulous preparation of the insertion site, and adherence to strict aseptic techniques. The choice of catheter size and material, as well as the insertion site (commonly the long saphenous vein in the lower extremity or the basilic vein in the upper extremity), were based on clinical judgment and patient characteristics.

Throughout the study period, data was systematically collected, compiled, and analyzed using statistical tools to identify trends, associations, and outcomes related to PICC line utilization in neonates. Descriptive statistics such as mean, standard deviation, frequency, and percentage were calculated, and analytical statistics were employed to assess for any significant correlations or differences.

Results

In Table 1, the gender distribution of the study participants indicates that out of the 47 neonates with PICC lines, 57.4% were male and 42.6% were female. This suggests a slightly higher representation of males in the study population.

Table 2 provides insight into the gestational age distribution of the neonates with PICC lines. It reveals that the majority of the neonates (55.3%) were born between 26 to 30 weeks of gestation, followed by 40.4% born between 31 to 35 weeks, and a smaller proportion (4.3%) born between 36 to 40 weeks. This highlights the predominance of preterm neonates in the study cohort.

The distribution of birth weights, as shown in Table 3, indicates that a significant proportion of neonates with PICC lines had low birth weights. Specifically, 42.6% were in the range of 700 to 1000 grams, while 46.8% fell between 1001 to 1500 grams. Additionally, 8.5% weighed between 1501 to 2000 grams, and smaller percentages were distributed across higher weight categories. This underscores the vulnerability of low birth weight neonates requiring PICC lines for medical interventions.

In Table 4, the mode of delivery among neonates with PICC lines is depicted. It reveals that 61.7% of neonates were delivered via normal vaginal delivery (NVD), while 38.3% were delivered via lower segment caesarean section (LSCS). This distribution reflects the varied obstetric contexts in which neonates requiring PICC lines are born.

Table 5 provides insight into the indications for lower segment caesarean section (LSCS) among neonates with PICC lines. The most common indication observed was fetoplacental insufficiency, accounting for 22.22% of cases, followed by imminent eclampsia and preterm premature rupture of membranes (PPROM) each at 16.73%. These findings shed light on the maternal health conditions necessitating surgical intervention for delivery in this population.

The distribution of comorbidities at the time of admission to the neonatal intensive care unit (NICU) is presented in Table 6. It reveals that among neonates with PICC lines, various

comorbidities were present, including birth asphyxia, intrauterine growth restriction (IUGR), preterm birth, respiratory distress, convulsions, and hypoglycemia. This underscores the complex medical needs of neonates requiring PICC lines and the importance of intensive care management upon admission to the NICU.

Discussion

The utilization of Peripherally Inserted Central Venous Catheters (PICC) in neonates presents a crucial aspect of neonatal care, particularly in cases where intravenous access is challenging or prolonged therapy is required. This discussion delves into the complications and outcomes associated with PICC lines in neonates, as observed in the study conducted at a tertiary care unit.

Complications of PICC Lines in Neonates

The findings of this study shed light on the spectrum of complications encountered with PICC lines in neonates. Among the observed complications, catheter-associated bloodstream infections (CABSI) emerged as a significant concern, affecting 14.9% of neonates with PICC lines. This aligns with existing literature emphasizing CABSI as one of the most prevalent complications associated with central venous catheters in neonates [1]. The incidence of CABSI underscores the importance of stringent infection control measures and catheter care protocols to mitigate the risk of bloodstream infections in this vulnerable population [5,6,11].

Another notable complication observed in this study is necrotizing enterocolitis (NEC), affecting 6.3% of neonates with PICC lines. NEC is a severe gastrointestinal condition associated with significant morbidity and mortality in preterm neonates, and its occurrence in neonates with PICC lines underscores the need for heightened vigilance and careful monitoring of gastrointestinal symptoms in this population. These findings are consistent with previous studies highlighting the association between NEC and central venous catheter use in neonates [2].

Furthermore, phlebitis emerged as a noteworthy complication, affecting 4.3% of neonates with PICC lines in this study. Phlebitis, characterized by inflammation of the vein wall, can lead to pain, swelling, and compromised catheter function. The incidence of phlebitis underscores the importance of regular assessment of catheter insertion sites and early detection of inflammation to prevent further complications [11-14].

Other complications observed in this study include catheter occlusion, difficult catheter removal, and sepsis, each affecting a small proportion of neonates with PICC lines. While these complications may not be as prevalent as CABSI or NEC, they nonetheless contribute to the overall burden of PICC-related complications and highlight the need for comprehensive monitoring and management strategies.

Outcomes of PICC Lines in Neonates

Despite the challenges posed by complications, PICC lines play a crucial role in facilitating essential medical interventions and therapies in neonates. The majority of neonates in this study (83.1%) were discharged with successful PICC line management, underscoring the overall favorable outcomes associated with PICC lines in neonatal care. However, it is imperative to acknowledge the small proportion of neonates (8.5%) who experienced

mortality despite PICC line placement, highlighting the need for continued efforts to optimize catheter management and minimize associated risks.

The outcomes observed in neonates with PICC-related complications provide valuable insights into the clinical course and management strategies employed in this population. Among neonates with CABSIs, the majority were successfully discharged, underscoring the effectiveness of antimicrobial therapy and supportive care in managing catheter-related bloodstream infections. However, it is essential to address the underlying factors contributing to CABSIs, such as catheter care practices and infection control measures, to prevent recurrence and improve outcomes in future cases [1,9,14].

Similarly, neonates with NEC experienced varied outcomes, with some successfully discharged and others experiencing mortality. The management of NEC in neonates with PICC lines poses unique challenges, as the presence of a central venous catheter may exacerbate gastrointestinal symptoms and complicate treatment strategies. Close collaboration between neonatologists, pediatric surgeons, and infectious disease specialists is essential to optimize outcomes in neonates with NEC and concurrent PICC line use [5-9].

The occurrence of phlebitis and other local complications highlights the importance of proactive catheter management and vigilant monitoring of insertion sites. Early recognition of phlebitis and prompt intervention, such as catheter removal or site rotation, can mitigate the risk of progression to more severe complications and improve overall catheter outcomes.

Factors Influencing PICC Line Management

Several factors may influence the duration of PICC line placement and the decision to remove the catheter in neonates. Gestational age, birth weight, underlying medical conditions, and the indication for PICC line insertion are important considerations in determining the optimal duration of catheter placement. Neonates with lower gestational age and birth weight may have prolonged hospital stays and require extended intravenous therapy, necessitating longer PICC line dwell times [14,15].

Indications for PICC line insertion, such as the need for parenteral nutrition, prolonged antibiotic therapy, or hyperosmolar solutions, also influence catheter management decisions. Close monitoring of neonatal clinical status, laboratory parameters, and infectious risk factors is essential in determining the appropriate timing for PICC line removal and transition to alternative forms of therapy.

Additionally, the occurrence of complications, such as CABSIs or phlebitis, may prompt early removal of the PICC line to mitigate the risk of further complications and improve overall patient outcomes. Catheter-related complications necessitate a multidisciplinary approach involving neonatologists, infectious disease specialists, and nursing staff to assess the clinical significance of complications and implement timely interventions [5,8,10,14].

Limitations and Future Directions

It is essential to acknowledge the limitations of this study, including its retrospective nature and reliance on medical record data. Retrospective studies are susceptible to biases and may lack comprehensive data on all relevant variables. Future prospective studies with larger sample sizes and longer follow-up periods are warranted to further elucidate the complications and outcomes associated with PICC lines in neonates.

Additionally, the study focused on a single tertiary care center, which may limit the generalizability of the findings to other healthcare settings. Collaborative multicenter studies

involving diverse patient populations are needed to validate the observed trends and identify potential variations in PICC line management practices across different healthcare institutions.

Conclusion

In conclusion, PICC lines play a crucial role in delivering essential medical therapies to neonates but are associated with a spectrum of complications that require diligent monitoring and management. Catheter-related bloodstream infections, necrotizing enterocolitis, and phlebitis are among the notable complications observed in this study, highlighting the need for comprehensive catheter care protocols and infection control measures. Despite these challenges, the majority of neonates with PICC lines experience favorable outcomes, emphasizing the importance of judicious catheter management and multidisciplinary collaboration in neonatal care. Continued research efforts are needed to further elucidate the factors influencing PICC line management and optimize outcomes for neonates requiring intravenous therapy.

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Tables

Table 1: Gender Distribution of Study Participants

Gender	Frequency	Percent
Male	27	57.4
Female	20	42.6

Total	47	100.0
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Table 2: Gestational Age Distribution of Study Participants

Gestational Age (Weeks)	Frequency	Percent
26-30	26	55.3
31-35	19	40.4
36-40	2	4.3
Total	47	100.0

Table 3: Birth Weight Distribution of Study Participants

Birth Weight (grams)	Frequency	Percent
700-1000	20	42.6
1001-1500	21	46.8
1501-2000	4	8.5
2001-2500	1	2.1
2501-3000	1	2.1
Total	47	100.0

Table 4: Indication for PICC Line Insertion

Indication	Frequency	Percent
IV infusion in preterm	36	76.5
Difficult venous access	6	12.8
Prolonged antibiotic administrations	1	2.1
Infusion of high concentrated glucose	2	4.3
Post-operative management	2	4.3
Total	47	100.0

Table 5: Complications Observed in Neonates with PICC Lines

Complication	Frequency	Percent
CABSI	7	14.9
Sepsis	2	4.3
NEC	3	6.3
Phlebitis	2	4.3
Occlusion	1	2.1
Difficult to remove	1	2.1
No complication	31	66.0
Total	47	100.0

Table 6: Outcome of Neonates with PICC Lines

Outcome	Frequency	Percent
Discharged	39	83.1
Expired	4	8.5
LAMA (Left Against Medical Advice)	2	4.2
Referred To Higher Center	2	4.2
Total	47	100.0