

## ORIGINAL ARTICLE

# Characterization of peripherally inserted central catheter use in patients of a neonatal intensive care unit at a Peruvian institute

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## ABSTRACT

**Objective:** To describe the characteristics of peripherally inserted central catheter (PICC) use in patients admitted to the neonatal intensive care unit of the Instituto Nacional Materno Perinatal (Lima, Peru) during 2023.

**Methods:** A descriptive, longitudinal, retrospective study was conducted. Information on the variables of interest was obtained from the PICC insertion and follow-up registry documented in each patient's medical record. Statistical analysis was performed using STATA v.15.0 software. The study was approved by the hospital's Research Ethics Committee.

**Results:** A total of 137 PICCs were inserted in the same number of patients. Most PICCs were inserted in preterm infants (<36 weeks) (89.8%), with a birth weight of <1,000 g (39.4%), requiring invasive mechanical ventilation (78.1%), and with a diagnosis of hyaline membrane disease (48.9%). The primary indication for placement was parenteral nutrition (78.8%). The most frequently used access veins were the basilic vein (38.7%) and the cephalic vein (29.2%). In 97.1% of cases, the final catheter tip position was in the superior vena cava. Complications were observed in 76.6% of patients during insertion and in 32.9% after insertion. The most frequent complications were malposition and catheter migration. Catheter-related sepsis occurred in 8.8 % of patients, with coagulase-negative *Staphylococcus* being the most frequently isolated microorganism.

**Conclusions:** PICCs were primarily inserted in preterm newborns with extremely low birth weight for the administration of parenteral nutrition. Complications occurred most frequently during the insertion procedure. These findings highlight the need to strengthen clinical practices through the training of specialized teams and the implementation of systematic follow-up programs to optimize PICC use and improve the quality of neonatal care.

**Keywords:** Peripheral catheterization; Neonatal Intensive Care Units; Infant, Newborn; Parenteral Nutrition; Complications (Source: MeSH)

## Cite as:


Espíritu Flores AJ, Córdova Rebatta JC, Avila Gallardo KJ, Cahua Heredia LM, Quispe Castillo M, Corcuera Segura GE. Characterization of peripherally inserted central catheter use in patients of a neonatal intensive care unit at a Peruvian institute. *Investig Innov Clin Quir Pediatr.* 2025;3(2):5-11.  
doi: 10.59594/iicqp.2025.v3n2.139

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## Caracterización del uso del catéter venoso central de inserción periférica en pacientes de una unidad de cuidados intensivos neonatal de un instituto peruano

Received : 03/12/2025

Accepted : 09/26/2025

Published : 11/05/2025

## RESUMEN

**Objetivo:** Describir las características del uso del catéter venoso central de inserción periférica (PICC) en pacientes atendidos en el servicio de cuidados intensivos neonatal del Instituto Nacional Materno Perinatal (Lima, Perú), durante el 2023.

**Métodos:** Estudio descriptivo, longitudinal, retrospectivo. La información de las variables de interés se obtuvo del registro de colocación y seguimiento del PICC consignando en la historia clínica de cada paciente. El análisis estadístico se llevó a cabo utilizando el software STATA vs 15.0. El estudio contó con la aprobación del Comité de Ética en Investigación del instituto.

**Resultados:** Se insertaron 137 PICC en un número igual de pacientes. En su mayoría, los PICC fueron insertados en prematuros (< 36 semanas) (89,8 %), con un peso al nacer menor a 1000 g (39,4 %), con ventilación mecánica invasiva (78,1 %) y con diagnóstico de membrana hialina (48,9 %). La colocación fue esencialmente para administración de nutrición parenteral (78,8 %). Las principales venas de acceso



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fueron las venas basilicas (38,7 %) y cefálicas (29,2 %). En el 97,1 % de casos, la ubicación final del catéter fue la vena cava superior. Se observaron complicaciones en el 76,6 % y 32,9 % de pacientes durante y posterior a la inserción respectivamente. Las complicaciones más frecuentes fueron la posición inadecuada y la migración del catéter. El 8,8% de pacientes presentaron sepsis por catéter siendo el principal microorganismo aislado el *Staphylococcus coagulasa* negativo.

**Conclusiones:** Los catéteres fueron insertados principalmente en recién nacidos prematuros con extremo bajo peso, para la administración de nutrición parenteral. Las complicaciones se presentaron con mayor frecuencia durante el procedimiento de inserción. Estos hallazgos resaltan la necesidad de fortalecer las prácticas clínicas mediante la capacitación de equipos especializados y la implementación de programas de seguimiento sistemático, con el fin de optimizar su uso y mejorar la calidad de la atención neonatal.

**Palabras clave:** Cateterismo Periférico; Unidades de Cuidado Intensivo Neonatal; Recién Nacido; Nutrición Parenteral; Complicaciones (Fuente: DeCS)

## INTRODUCTION

In neonatal intensive care units (NICUs), the insertion and maintenance of a peripherally inserted central catheter (PICC) represent an ongoing challenge for nursing professionals, as this procedure requires the development of specialized skills and expertise. The PICC is an essential, effective, and safe tool for administering medications, solutions, and parenteral nutrition, playing a crucial role in the survival of many newborns (1).

Compared to other vascular access methods, such as central venous catheters (CVCs), PICCs provide several benefits, including higher placement success rates, better cost-effectiveness, lower infection rates, and longer-lasting vascular access. Moreover, they are a suitable option for administering hyperosmolar medications and parenteral nutrition (2). However, their use may be associated with complications, including infections and thrombosis (3).

Studies conducted internationally in countries such as Ecuador, Spain, and Brazil consistently report that the main users of PICCs are preterm neonates (64.5% (4), 75.0% (1), 84.4% (5), 86.0% (6), 87.6% (7)), with very low birth weight (1000–1499 g) (29.3% (5), 51.6% (4), 25.9% (1), 35.6% (7)), and diagnoses such as respiratory distress syndrome (45.9% (6)), hyaline membrane disease (41.9% (4)), and neonatal infections (27.04% (6)), among other conditions. The most frequently used veins for catheter insertion are the basilic and cephalic veins (4,5,7), while the main reason for catheter removal is treatment completion (44.0% (6), 48.4% (4), 56.2% (7), 60.2% (3)). Reported complication rates associated with PICC insertion and maintenance vary across studies, ranging from 16.4% (1) to 46.5% (6), with values of 26.3% (7) and 32.2% (3) also reported. The most common complications include malposition, obstruction, infiltration/extravasation, and infections. Less frequent complications include arrhythmias and pleural or pericardial effusions (1, 3, 4, 6, 7).

At the national level, studies conducted among neonatal populations in Lima and other regions of Peru have shown

results similar to those reported internationally. These studies have documented that 68.2% of neonatal patients with PICCs are preterm (8), 45.0% have a birth weight below 1500 g (9), and 51.8% present with surgical conditions (8). Furthermore, the most common diagnoses for PICC placement include prematurity and hyaline membrane disease (70.3%) (10). Reported complication rates associated with PICC insertion and maintenance range from 11.1% (10) to 82.4% (9), with the latter exceeding international reports, underscoring the need for continued research to identify opportunities for improvement in PICC placement practices in Peru.

In 2023, the Instituto Nacional Materno Perinatal (INMP) recorded a total of 12,472 births, with 98.9% (n = 12,333) being live births. This number shows a decrease compared to previous years, mainly due to a decline in deliveries (11). Nonetheless, the number of critically ill neonates remained steady. That same year, 677 critically ill neonates were admitted to the NICU, of whom 76.1% were preterm and 99.7% required mechanical ventilation. In this group of patients, 325 PICCs were placed (12).

In this context, the present study aimed to describe the characteristics of PICC use in patients admitted to the INMP NICU in 2023. The findings are expected to serve as a basis for future research in larger cohorts to identify specific areas for improvement in PICC use and reduce the risk of complications in neonates.

## METHODS

### Study type and design

A descriptive, longitudinal, retrospective study was conducted in the NICU of the INMP.

### Population and sample

The study population consisted of patients hospitalized in the NICU who required PICC placement between February and July 2023. Newborns admitted to the institution who underwent their first catheter placement during the study period were included in the analysis. Patients who died, were transferred, or required a second placement were excluded from the study. Non-probability convenience sampling was used.

PICC insertions were performed by nursing professionals specialized in the care of neonatal intensive care patients, in accordance with the INMP procedural guidelines (13). Nursing professionals performed daily clinical monitoring of neonates to assess complications and catheter duration until removal.

### Variables, instruments, and data collection

The variables studied included gestational age, birth weight, primary diagnosis, and characteristics of PICC insertion and maintenance, including catheter type (double-lumen polyurethane and single-lumen silicone), number of attempts, veins used (pericranial, jugular, basilic, cephalic, axillary, dorsal arch, and lower limb veins), insertion-related complications (malposition of the catheter tip and insertion

difficulty), and post-insertion complications (catheter-related sepsis, migration, occlusion, and bleeding), among others considered relevant to the analysis.

For this study, central position was defined as the location of the catheter tip in the superior or inferior vena cava, confirmed by radiography; malposition was defined as the catheter tip being located outside the central position, requiring repositioning and, in some cases, a new venipuncture attempt; suspected catheter-associated sepsis was defined as the presence of clinical signs compatible with infection, after ruling out other sources, which led to PICC removal and simultaneous culture of the catheter tip and peripheral blood; catheter-related sepsis was defined as bloodstream infection associated with a PICC, diagnosed by clinical signs and confirmed by the isolation of the same microorganism in both the catheter tip culture and the blood culture; and migration was defined as catheter displacement from its central location.

Data on the variables of interest were obtained from the PICC placement and follow-up records documented in each patient's medical chart.

**Statistical analysis**

Data were processed using STATA version 15. Descriptive analyses were performed to characterize the study population and the use of PICCs. Categorical variables were expressed as absolute and relative frequencies (percentages). Numerical variables were grouped into ranges and expressed as frequencies and percentages, according to their nature.

**Ethical considerations**

The study was approved by the INMP Research Ethics Committee. Clinical consent was obtained for PICC placement. As the data were derived from PICC placement and follow-up records, additional informed consent for study participation was not required. Data were transferred to an anonymized database without identifiers, ensuring confidentiality and data protection in accordance with current regulations.

**RESULTS**

A total of 137 PICCs were inserted in an equal number of patients. The main epidemiological and clinical characteristics of the patients are presented in Table 1. Of the 137 patients, 89.8% were preterm, 54.0% had a gestational age of less than 32 weeks, 72.2% weighed less than 1500 g at birth, and 51.1% were male. Most neonates had extremely low birth weight (<1000 g) (39.4%). Invasive mechanical ventilation was required in 78.1% of cases, and the most frequent diagnosis was hyaline membrane disease (48.9%).

Table 2 summarizes the main characteristics of PICC use in the study population. The primary indication for placement was total parenteral nutrition (78.8%). Most procedures lasted between 60 and 120 minutes (65.7%). The most frequently used veins were the basilic and cephalic veins, which together accounted for 67.9% of all insertions. Two attempts were required in 34.3% of cases, mainly due to difficulty advancing

**Table 1.** Características epidemiológicas y clínicas de la población de estudio (n=137)

| Characteristic                   | n  | %    |
|----------------------------------|----|------|
| <b>Gestational age</b>           |    |      |
| < 28 weeks                       | 34 | 24.8 |
| 28–31 6/7 weeks                  | 40 | 29.2 |
| 32–36 6/7 weeks                  | 49 | 35.8 |
| 37–41 6/7 weeks                  | 14 | 10.2 |
| <b>Birth weight*</b>             |    |      |
| < 1,000 g (ELBW)                 | 54 | 39.4 |
| 1,000–1,499 g (VLBW)             | 45 | 32.8 |
| 1,500–2,499 g (LBW)              | 27 | 19.7 |
| ≥ 2,500 g (normal or macrosomic) | 11 | 8.1  |
| <b>Age at birth (days)</b>       |    |      |
| ≤ 7                              | 85 | 62   |
| > 7                              | 52 | 38   |
| <b>Medical diagnosis **</b>      |    |      |
| <b>Respiratory</b>               |    |      |
| Hyaline membrane disease         | 67 | 48.9 |
| Neonatal pneumonia               | 15 | 10.9 |
| Bronchopulmonary dysplasia       | 11 | 8    |
| Others                           | 12 | 9.5  |
| <b>Infectious</b>                |    |      |
| Sepsis                           | 39 | 28.5 |
| Others                           | 17 | 12.4 |
| <b>Cardiological</b>             |    |      |
| Patent ductus arteriosus         | 20 | 14.6 |
| Congenital heart diseases        | 4  | 2.9  |
| <b>Surgical</b>                  |    |      |
| Gastroschisis                    | 16 | 11.7 |
| Others                           | 13 | 9.4  |
| <b>Metabolic disorder</b>        |    |      |
|                                  | 14 | 10.2 |
| <b>Neurological</b>              |    |      |
|                                  | 8  | 5.8  |
| <b>Other diagnoses</b>           |    |      |
|                                  | 17 | 12.4 |

\*ELBW: Extremely low birth weight; VLBW: Very low birth weight; LBW: Low birth weight.

\*\*All patients had more than one medical diagnosis.

the catheter (46.7%). Finally, in 97.1% of cases, the final catheter position after repositioning during placement was the superior vena cava (Table 2).

In 53.3% of cases, PICCs remained in place for fewer than 15 days. The mean duration was 15.1 days (range, 1–51 days). Most patients did not require dressing changes (51.8%). Among those who did, 56% were due to repositioning. The main reason for PICC removal was completion of treatment (43.0%), followed by suspected infection (Table 3).

Table 4 summarizes the information on complications related to PICC insertion. During the procedure, 23.4% of patients experienced no complications, 50.4% experienced

**Table 2.** Characteristics of PICC placement in NICU patients at INMP (n=137)

| Characteristic  | n   | %    |
|---|-----|------|
| <b>Indication for placement</b>                       |     |      |
| Total parenteral nutrition                            | 108 | 78.8 |
| Infusion of vasoactive drugs                          | 20  | 14.6 |
| Other   | 9   | 6.6  |
| <b>Duration of PICC placement procedure (minutes)</b> |     |      |
| < 60  | 30  | 21.9 |
| 60 – 120  | 90  | 65.7 |
| > 120   | 17  | 12.4 |
| <b>Catheter type and size</b>                         |     |      |
| Double-lumen polyurethane, 2 Fr                       | 74  | 54   |
| Single-lumen silicone, 1.9 Fr                         | 63  | 46   |
| <b>Access veins</b>                                   |     |      |
| Basilic   | 53  | 38.7 |
| Cephalic  | 40  | 29.2 |
| Axillary  | 25  | 18.3 |
| Pericranial   | 7   | 5.1  |
| Neck  | 4   | 2.9  |
| Dorsal arch   | 4   | 2.9  |
| Lower limbs   | 4   | 2.9  |
| <b>Number of insertion attempts</b>                   |     |      |
| 1   | 44  | 32.1 |
| 2   | 47  | 34.3 |
| >2  | 46  | 33.6 |
| <b>Reason for ≥ 2 attempts</b>                        |     |      |
| Total   | 93  | 100  |
| Advancement difficulty                                | 59  | 63.4 |
| Vein rupture  | 27  | 29   |
| Advancement difficulty + vein rupture                 | 6   | 6.5  |
| Failed puncture                                       | 1   | 1.1  |

**Table 3.** Maintenance and removal characteristics of PICCs in NICU patients at INMP (n=137)

| Characteristic                                | n           | %    |
|---|-------------|------|
| <b>Catheter dwell time (days)</b>             |             |      |
| < 15  | 73          | 53.3 |
| 15–30   | 56          | 40.9 |
| > 30  | 8           | 5.8  |
| Mean PICC dwell time (range, days)            | 15,1 (1-51) |      |
| <b>Dressing changes</b>                       |             |      |
| <b>Number of dressing changes</b>             |             |      |
| None  | 71          | 51.8 |
| 1   | 49          | 35.8 |
| 2   | 12          | 8.8  |
| > 3   | 5           | 3.6  |
| <b>Timing of first dressing change (days)</b> |             |      |
| < 1   | 15          | 30.6 |
| 1–7   | 16          | 32.7 |
| > 7   | 18          | 36.7 |
| <b>Reason for dressing changes</b>            |             |      |
| Replacement                                   | 37          | 56   |
| Dressing with residual bleeding               | 24          | 36.4 |
| Adhesive dressing detached                    | 5           | 7.6  |
| <b>Reason for PICC removal</b>                |             |      |
| End of treatment                              | 59          | 43   |
| Death   | 23          | 16.8 |
| Suspected infection                           | 40          | 29.2 |
| Occlusion                                     | 2           | 1.5  |
| Breakage                                      | 1           | 0.7  |
| Catheter tract hardening                      | 3           | 2.2  |
| Displacement                                  | 9           | 6.6  |

one complication, and 26.2% experienced two or more complications. The most frequent complications were malposition and difficulty advancing, which were corrected before fixation, ensuring central placement. After insertion, 67.1% of patients had no complications, while 32.9% did, with migration being the most common (Table 4).

Forty catheters were removed due to suspected infection, and their tips were cultured for bacterial analysis. Of these, 28 were negative. In the 12 positive cases, the same microorganism was identified in both the catheter tip culture and blood culture, with coagulase-negative *Staphylococcus* being the most frequent (Table 5).

## DISCUSSION

This is the first descriptive study conducted in the INMP NICU addressing this objective, in a context where PICC insertion and maintenance are essential procedures performed by nursing professionals. In the studied sample, 137 catheters were inserted, mostly in preterm neonates (<36 weeks) (89.8%), a finding consistent with Swerts *et al.* (6) and other studies, which have shown that most PICCs are placed in preterm populations (1, 6, 7).

In terms of gestational age, 54.0% of neonates were under 32 weeks, a lower proportion than that reported by Chulle *et al.* (10) (60.4%) but higher than that described by Aguilar *et al.* (8) (36.4%). Regarding birth weight, a higher prevalence of extremely low birth weight (<1,000 g) neonates was observed, accounting for 39.4%. This proportion is similar to that reported by Bayoumi *et al.* (14) (42.0%), although higher

**Table 4.** Frequency of complications reported during and after PICC insertion in NICU patients at INMP (n=137)

| Complication                          | n  | %    |
|---------------------------------------|----|------|
| <b>Complications during insertion</b> |    |      |
| <b>No complications</b>               | 32 | 23.4 |
| <b>Single complication</b>            | 69 | 50.4 |
| Malposition                           | 27 | 19.7 |
| Difficulty advancing                  | 24 | 17.5 |
| Vascular injury                       | 10 | 7.3  |
| Bleeding                              | 8  | 5.8  |
| <b>Two complications</b>              | 36 | 26.3 |
| Malposition + difficulty advancing    | 26 | 19   |
| Bleeding + difficulty advancing       | 4  | 2.9  |
| Bleeding + malposition                | 3  | 2.2  |
| Vascular injury + malposition         | 3  | 2.2  |
| <b>Complications after insertion</b>  |    |      |
| No complications                      | 92 | 67.1 |
| Migration                             | 28 | 20.4 |
| Catheter-related sepsis               | 12 | 8.8  |
| Occlusion                             | 3  | 2.2  |
| Phlebitis                             | 2  | 1.5  |

**Table 5.** Microorganisms isolated from PICC tip cultures and blood cultures in NICU patients with suspected sepsis at INMP (n=40)

| Microorganism                            | n  | %  |
|--|----|----|
| None                                     | 28 | 70 |
| <i>Pseudomonas aeruginosa</i>            | 2  | 5  |
| Coagulase-negative <i>Staphylococcus</i> | 10 | 25 |

than the 13.6% reported in another national study (8). These differences may be attributed to the fact that INMP is a referral center for high-risk pregnancies, leading to a greater number of preterm births and extremely low birth weight neonates.

PICC use is primarily indicated for preterm neonates, neonates with very low or extremely low birth weight, and critically ill infants (15). Preterm neonates exhibit specific physiological characteristics, such as gastrointestinal immaturity, which justifies the need for parenteral nutrition as either the sole source of nutritional support or as a complement to enteral feeding. Critically ill infants also require nutritional support or rescue therapy (16). For these patients, it is essential to have a secure venous access that minimizes manipulation and reduces unavoidable external stressors during hospitalization (8). At INMP, parenteral nutrition is administered concurrently with enteral feeding, starting early and progressing gradually, given its significant impact on the health of preterm infants by improving micronutrient supply, neurodevelopment, intestinal maturation, and microbiome development.

The average duration of PICC insertion was 60 to 120 minutes in 65.7% of cases. To date, no uniform standard has been established for defining this duration. For instance, Canales *et al.* (17) reported a median of 92.5 minutes with an interquartile range of 80–120 minutes. Procedure duration may be influenced by multiple factors, including nursing staff experience, venous quality (particularly in extremely preterm infants), and the waiting time for radiographic evaluation before catheter fixation, which could be explored in future studies.

With respect to venous access selection, the basilic vein was the most frequently used (38.7%), consistent with findings reported by Carneiro *et al.* (5) (34.1%), Menéndez *et al.* (4) (48.4%), Aguilar *et al.* (8) (27.3%), and Mercado and Montánchez (9) (43.8%). In contrast, Chulle *et al.* (10) identified the cephalic vein as the most commonly used, differing from the present study. The literature indicates that both the basilic and cephalic veins can be used for PICC insertion. Nonetheless, the basilic vein is usually preferred because of its larger size, advantageous anatomical path, and reduced risk of complications (8,18).

Regarding the catheter tip position, all catheters were placed centrally, with 97.1% reaching the superior vena cava, as confirmed by radiography. These results are consistent with those reported by Wosnes *et al.* (19) (>80%) but are higher than those found by Rangel *et al.* (7) and Tomasoni *et al.* (20) (34.3% and 38.6%, respectively). Guidelines recommend positioning the catheter tip at the junction of the lower third of the superior vena cava with the right atrium, avoiding entry into the cardiac chamber (21). This is crucial to prevent complications such as thrombosis (if the tip is in the upper superior vena cava or subclavian vein), arrhythmias, and valvular dysfunction (18). Current methods to verify tip position include radiography and ultrasound (22), and institutional guidelines recommend confirming the catheter position radiographically before final fixation (13).

As for the number of insertion attempts, 34.3% of cases required two attempts, similar to the 32.7% reported by Aguilar *et al.* (8). However, Prado *et al.* (23) reported that three or more puncture attempts were necessary in 63.9% of cases, whereas Chulle *et al.* (10) reported a 52.6% first-attempt success rate. The main reason for additional attempts was difficulty advancing the catheter (46.7%). According to Palleja *et al.* (22), this issue may be related both to operator experience and patient anatomical conditions. Previous studies suggest that training in vascular anatomy, coupled with practical experience, can help reduce the number of attempts and the incidence of complications (10,24).

PICC dwell time ranged from 1 to 51 days. These findings differ from those reported by Ávila *et al.* (25) (1–33 days), Konstantinidi *et al.* (26) (3–31 days), and Li *et al.* (15) (1–62 days). The mean dwell time was 15.1 days, shorter than that reported by Chulle *et al.* (10) (19.6 days) but longer than Prado *et al.* (23) (12.6 days). Catheter duration may be extended if proper maintenance measures are followed; however, early removal may occur due to patient death, suspected infection, or catheter malposition (8). The CDC recommends removing PICCs as soon as they are no longer needed to reduce the risk of catheter-associated infections,

which increases with prolonged dwell time. Nonetheless, no standard dwell time has been established, highlighting an area for future investigation (27).

Daily site assessment revealed that 51.8% of PICCs did not require dressing changes. This finding aligns with Chulle *et al.* (10), who reported that routine dressing changes were not performed. Similarly, Prado *et al.* (23) emphasized that dressing changes should be carefully evaluated to minimize skin trauma and prevent catheter displacement. The primary reason for catheter removal was treatment completion (43.0%), consistent with Swerts *et al.* (6) (44.0%) and Rangel *et al.* (7) (56.2%). In 29.2% of cases, removal was due to suspected infection, comparable to the 37.3% reported by Aguilar *et al.* (8).

Although PICC use offers multiple advantages, it is not without complications. In our study population, the most frequent insertion-related complication was malposition of the tip (43.1%), consistent with Razavinejad *et al.* (28) (48.2%). Post-insertion, catheter migration occurred in 20.4% of cases, lower than the 28.0% reported by Acun *et al.* (29). Catheter-associated infection occurred in 8.8% of cases, with coagulase-negative *Staphylococcus* as the predominant pathogen, in agreement with Faunes *et al.* (3).

This study has some limitations. First, due to its descriptive design, it was not possible to establish group comparisons or evaluate associations between variables. Additionally, specific potentially relevant data that could have influenced PICC outcomes, such as operator experience, the number of catheters placed per operator, insertion frequency, and individual success rates, were not collected.

Strengths include the sample size and inclusion of neonates with diverse clinical characteristics, such as gestational age, birth weight, and primary diagnosis. Furthermore, this is the first study addressing this objective at INMP, a referral center for high-risk neonates.

Future studies, preferably multicenter with larger cohorts, could help identify specific areas for improvement in PICC use nationally and inform strategies to reduce complication risks in this high-risk population.

## CONCLUSION

This study enabled the characterization of PICC use in patients admitted to the INMP NICU in 2023. Catheters were primarily inserted in preterm neonates with extremely low birth weight, mainly for parenteral nutrition. A notable frequency of insertion-related complications was identified, highlighting the need to optimize practices associated with PICC use. Our findings emphasize the importance of establishing specialized teams and implementing training programs with systematic monitoring, aimed at reducing risks and improving the quality of neonatal care.

### Author contributions

All authors: Conceptualization, data curation, formal analysis, investigation, methodology, project administration,

resources, supervision, visualization, writing – original draft, and writing – review and editing.

### Conflicts of interest

The authors declare no relevant financial or non-financial conflicts of interest.

### Funding

This research was self-funded.

### Acknowledgments

To the nurses of the Neonatal Intensive Care Unit at the Instituto Nacional Materno Perinatal, Lima, Peru.

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