

## Non-elective removal of the peripherally inserted central catheter in the neonatal unit

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### ABSTRACT

The objective was to identify the determinant factors of the non-elective removal of the peripherally inserted central catheter in newborns admitted to a Neonatal Intensive Care Unit. A cross-sectional study conducted in reference maternity for high-risk maternal-infant attention located in Northeastern Brazil. The data collection was conducted with 108 neonates during February to November 2016. We observed the prevalence of male neonates (60.19%), born from cesarean section birth (74.07%) and low weight at birth (29.62%). The non-elective removal occurred in 41.66% neonates by infiltration (12.03%), accidental traction (11.11%), external rupture (9.25%), occlusion (5.55%), bad positioning (1.85%) and infection suspicion (1.85%). The prevalence and non-elective removal factors indicated the need for Nursing strategies to prevent avoidable complications catheter-related, noting the training and improvement of abilities regarding insertion, maintenance, removal and, observation of this device.

**Descriptors:** Neonatal Nursing; Intensive Care, Neonatal; Catheterization, Peripheral; Device Removal.

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## INTRODUCTION

The Neonatal Intensive Care Unit (NICU) aims to promote conditions to revert health issues that risk the newborn's (NB) life, using high technology devices and/or specific and complex procedures, like endovenous therapy through peripheral and central venous accesses<sup>(1-2)</sup>.

Nowadays, the Peripherally Inserted Central Catheter (PICC) is a broadly used alternative for this purpose as it is considered safe and effective access. It is a long, flexible catheter inserted by a sterile technique through a peripheral vasa and up to a distal third of the superior or inferior vena cava, placed at the central level<sup>(3)</sup>. After putting the PICC, radiography should be taken to confirm the positioning and initiation of its use<sup>(4)</sup>.

The possibility of maintaining the intravenous therapy for a prolonged time, the reduction of peripheral punctures, besides avoiding the venous dissection practice are noted benefits of its use. After the umbilical venous catheterism (UVC), the PICC is the first choice for venous access<sup>(5)</sup>.

Usually, the PICC is used for the venous hydration, 12.5% glucose or higher concentration infusions, antibiotics, analgesics, chemotherapies, parenteral nutrition, blood infusion and blood-derivatives and, depending on its caliber, central venous pressure (CVP) monitoring or UVC substitution<sup>(6-7)</sup>.

The PICC is not free of risks and requires knowledge and specific technical abilities for its insertion and maintenance, to avoid complications that can appear with its handling<sup>(5,8)</sup>. Such difficulties can reflect in the NB's general state and, still, to extend the admission. The following events are considered complications: obstruction, leaking, rupture, infection, thrombosis, migration of the catheter tip. These correspond to 15% to 48% of intercurrents related to its use. Such complications result in the time reduction of PICC permanence, failure in the medication therapy and neonate survival<sup>(9)</sup>.

Considering the nurse role in assessing the NB venous network to install the PICC, trying to prevent post-insertion complications and, consequently, more safety for the patient, there is a need to identify the determinant factors for the non-elective PICC removal in newborns.

As for relevance basis for our study, an integrative literature review about the theme was conducted with the publications of the past five years, in the databases Scopus, PUBMED, Health Virtual Library: LILACS and MEDLINE with the descriptors: Neonatal Nursing; Catheterization Central Venous and Complications. Despite the theme relevance, only seven studies were identified addressing nursing care for complications related to catheter handling<sup>(1-2,8,10-13)</sup>.

Despite the theme relevance, especially for nurses responsible for the PICC insertion and maintenance, there were gaps in the literature related to determinants of non-elective removal in NB, justifying the conduction of the present study. Additionally, the occurrence of complications leading to unplanned catheter removal still does not have robust evidence to guide the clinical nursing practice regarding preventive strategies for this situation<sup>(1)</sup>. Therefore, it is believed that results from the present study will aggregate knowledge to the nursing team.

Besides, the endovenous therapy through safe access is essential for the viability of most neonates under intensive care, and the occurrence of adverse events can cause severe and irreversible consequences, due to NB's fragility. Also, the identification of these factors allows the Nurse to implement strategies to improve the scientific evidence-based assistance practice to decrease the frequency of unplanned PICC removal in this population.

Therefore, this study aimed to identify the determinant factors of the non-elective peripherally inserted central catheter removal in NB admitted to neonatal ICU.

## **METHODS**

This is a cross-sectional study with neonates admitted to the Neonate Intensive Care Unit (NICU) at a reference institution for high-risk maternal-infant attention, located in the Northeast region of Brazil.

For the sample calculation, we used the neonate population admitted at NICU in 2014, a total of 297 and from those 148 used PICC, that is, 49.83%. In 2015 and 2016, the prevalence of PICC use was 50.0% and 49.73%, respectively. To establish the study sample, the sample calculation for finite populations was used, to impartially propose safe and scientific effectiveness and efficacy of this study<sup>(14)</sup>. As a parameter for the sample calculation, a 95% confidence level and a 5% sample error were established. Due to lack of studies estimating the PICC use prevalence in NB, it was considered a 50% value for prevalence, considering the data found in reports of the Hospital Infection Commission Center of the referred institution. From this perspective, a sample of 108 NBs was estimated.

During the data collection period, there were 384 admissions to the NICU. It was adopted as inclusion criteria: neonates without diagnoses of coagulopathies and congenital abnormalities with loss of skin integrity and PICC use. As exclusion criteria: neonates born in another maternity and with catheters inserted in another institution. Nine NBs were excluded. Also, only the first catheter inserted in the NB in the sample was included. The participants were selected by convenience and a researcher collected information.

The data collection was from 01 February to 31 November 2016. The Unit choice is justified by being a sector that provides high complexity assistance with advanced technological resources, being the PICC used in routine practice. The unit has a protocol for insertion, maintenance, and removal of this device, besides the trained technical personnel.

A structured form adapted from an existing protocol in the unit named "PICC Installation and Removal Form" was used for data collection. This form aims to register, accompany and assess all catheters inserted in the unit, through data collection of patients regarding the device.

The variables were analyzed related to neonate's characteristics: sex, type of delivery, weight and gestational age in the catheter insertion date, 1<sup>st</sup> and 5<sup>th</sup> minute APGAR, admission time at the procedure date and, clinical diagnoses. The variables associated to the device insertion were: indications for PICC use, number of endovenous solutions at its indication, insertion position, initial location of the catheter tip after radiography, anti-septic used at the first dressing, permanence time and motives for its removal.

The descriptive data analyses were conducted using tables, being the categorical variables described using absolute and relative frequencies. The Excel® 2010 was used for data analysis.

The Ethics in Research Committee of the Rio Grande do Norte Federal University approved the study, under the protocol CAAE 48990515.0.0000.5292.

## RESULTS

Regarding the sample characterization (Table 1), 50% of NB used the PICC during the data collection period. There was predominance of males (60.19%), born through cesarean section (74.07%), with low weight at birth (29.62%) e with average APGAR of 6.72 and 7.60 at the first and fifth minute of life, respectively. Regarding the catheter insertion, 26.85% of NBs were with low weight at birth and gestational age above 32 weeks (62.03%). Notably, 59.25% of catheters were inserted until the third day of life.

The primary indications for catheter insertion were antibiotic therapy (47.94%) and parenteral nutrition (19.86%). Regarding the clinical diagnosis, the prematurity (92.59%) and respiratory infections (72.22%) were the most prevalent. The number of endovenous solutions in the PICC indication was of one type in its majority (68.51%).

Regarding the PICC insertion, the type of catheter used was the lumen unique and silicone. Regarding the insertion place, the upper limbs were the most prevalent (58.34%). Few catheters presented progression difficulty during its insertion (15.74%), and 20.37% of newborns had some intercurrent during the PICC insertion, being moderate bleeding or difficulty in the catheter progression. Nurses inserted all PICC.

Regarding the location of the catheter tip after radiography, 15.74% were located at the distal third portion of the superior vena cava or inferior vena cava. Notably, 56.48% of PICCs were located in the intra-cardiac level, and there was a need to draw the catheter to avoid cardiac complications.

In the NICU, nurses used only the aqueous chlorhexidine (95.37%) for anti-sepsis when changing dressings. The number of dressing changes was in its majority, lower than five changes (92.59%) during the catheter use. The mean time of PICC permanence was 12.6 days, varying from one to 89 days. According to the institution routine, the first dressing is done after 48 hours of the procedure, and the others are performed in the presence of dirtiness or loss of adherence.

The main reason for catheter removal was elective, by the end of treatment or patient's discharge (46.29%), and 41.66% were removed due to complications (Table 2). Notably, the most prevalent complication was infiltration (12.03%), followed by accidental catheter traction (11.11%) (Table 2). The catheters removed due to death represented 6.48% of the sample. Again, 5.55% of patients were not assessed regarding the PICC removal, as they needed to be transferred to another institution.

**Table 1:** Sociodemographic and clinical characteristics of newborns using peripherally inserted central catheter in Neonatal Intensive Care Unit. Natal, RN, Brazil, 2016.

Variables	Absolute Frequency	%
<b>Sex</b>		
Male	65	60.19
Female	41	37.96
Undefined	2	1.85
<b>Type of delivery</b>		
Cesarean	80	74.07
Vaginal	28	25.92
<b>Weight at insertion</b>		
Low weight	33	30.56
Normal	29	26.85
Very low weight	27	25.00
Extreme low weight	19	17.59
<b>Gestation age at insertion</b>		
> 32 weeks	61	56.48
< 32 weeks	47	43.51
<b>Admission duration (days)</b>		
< 3 days	64	59.25
> 3 days	44	40.74
<b>Clinical diagnosis</b>		
Prematurity	100	92.59
Respiratory disorder	78	72.22
Cardiopathy	25	23.14
Sepsis (early or late)	18	16.66
Metabolic transitory disorder	11	10.18
Asphyxia	7	6.48
<b>Number of endovenous solutions in the indication</b>		
1	74	68.51
2	30	27.77
3	4	3.70
<b>PICC insertion place</b>		
Upper limbs	63	58.33
Axillary	21	19.44
External jugular	11	10.18
Cephalic region	8	7.40
Lower limbs	5	4.62
<b>Catheter tip location</b>		
Intracardiac	61	56.48
Distal third of the superior/inferior vena cava	17	15.74
False trajectory	13	12.04
Sub-clavicle	9	8.33
Midline	6	5.56
<b>1<sup>st</sup> antiseptic dressing</b>		
Aqueous chlorexidine	103	95.37
Not performed	5	4.63

**Table 2:** Motive for removal of the peripherally inserted central catheter in newborns admitted to a Neonatal Intensive Care Unit. Natal, RN, Brazil, 2016.

Removal Motive	Absolute Frequency	%
Elective	50	46.29
Non-elective	45	41.64
Infiltration	13	12.03
Accidental traction	12	11.11
External rupture	10	9.25
Occlusion	6	5.55
Bad positioning	2	1.85
Infection suspicion	2	1.85

## DISCUSSION

The first catheters inserted in 108 NBs were analyzed, being 60.19% males and 74.07% born from cesarean delivery, which can be justified by the fact that the institution focuses on high-risk maternal-infant attention. Another study also pointed a predominance of 51.52% of male neonates and a higher incidence of cesarean delivery (74.23%)<sup>(15)</sup>.

A prevalence of NBs with low weight at birth (30.56%) during catheter insertion was observed, corroborating with the literature, which points that neonates submitted to PICC are mainly premature, low-weight, in need of the catheter to conduct the endovenous therapy<sup>(9,16)</sup>.

Most catheters were inserted in neonates of gestational age (GA) higher than 32 weeks (56.48%). Such characteristic can be related to the NB characteristics in the studied NICU. On the other hand, a study analyzed the PICC use in NICU found most catheters inserted in NBs with GA lower than 32 weeks (71.8%)<sup>(16)</sup>.

The majority of catheters were inserted until the third day of life. It was perceived a change in the actual profile of catheter insertion, as the procedure was preferably conducted from the 48 hours of the neonate's life due to the birth edema decrease and improvement in visualizing the venous network<sup>(17)</sup>. Such situation reflects the technical ability of the nurse trained for this type of procedure, once it is a technique requiring specific knowledge.

Regarding the clinical diagnosis, the prematurity was constituted as the leading cause of hospitalization (92.59%). Such condition favors the appearance of transitory metabolic disorders and hydro-electrolytic disorders due to the systems' immaturity. The literature demonstrates that neonates who presented such disorders have a higher rate of non-elective catheter removal<sup>(18)</sup>. Therefore, the nurse needs to be attentive to metabolic disorders to avoid complications leading to failed catheter use.

About the endovenous solutions, 68.51% of PICC was inserted to infuse a solution, being parenteral nutrition, antibiotic, venous hydration, or another type. A study pointed that the catheter indication for an average of three endovenous solutions was associated to the non-programmed PICC removal<sup>(18)</sup>. The infusion of multiple solutions in one single lumen catheter can result in obstruction and rupture. Therefore, the prevention of complications from these aggravations includes the maintenance care of catheter by the nursing team.

The most prevalent insertion place was upper limbs (58.33%), being 31.48% inserted in the right upper limb (RUL). It offers easier progression and centralization<sup>(10)</sup>, and it is closer to the vena cava<sup>(19)</sup>. Extended length, tortuous veins and with a high number of valves, can lead the catheter tip to progress to undesirable anatomic locations<sup>(19)</sup>. Therefore, the choice of vein to be punctured is a relevant factor in the initial position of the device tip and, consequently, for the procedure success.

The interferences during the catheter insertion represented 20.37% being: progression difficulty and moderate bleeding. The first can be caused by the venous anatomy; inappropriate NB positioning; an incorrect measure of the catheter after its cut; vascular resistance and absence of blood return, due to vasospasm, sclerosis, the presence of valves or venous bifurcation<sup>(20)</sup>.

The most predominant initial location of the catheter tip was the intracardiac (56.48%). A preventive strategy would be higher attention to the measurement of the catheter length to be inserted, that is, of the venous puncture location until the vena cava followed by the venous course<sup>(21)</sup>. The studied institution does not have a

standardized operation protocol (SOP) for catheter measurement. Therefore, it is indispensable to elaborate and implement an SOP to guarantee the procedure standard and to make it free of variations.

About the antiseptic used, the use of only aqueous chlorhexidine was observed. However, studies point that in neonates weighing less than 1,500 grams, the anti-germ chlorhexidine, followed by the 0.9% physiological solution. In neonates weighing more than 1,500 grams, the alcoholic chlorhexidine is indicated, and the removal should be done with the 0.9% physiological solution<sup>(9)</sup>. Thus, it is vital for the Nurse to cautiously analyze the material to be used in the neonate anti-sepsis considering the skin fragility.

The mean time of PICC permanence was 12.6 days. The Centers for Disease Control and Prevention (CDC) in the United States recommends its use for up to eight weeks<sup>(22)</sup>, and some studies indicate its use for up to six months<sup>(22)</sup>. The data of the present study are within the recommended limit by the CDC and by recent studies<sup>(20-22)</sup>.

A study that aimed to create a risk score for the non-elective PICC removal pointed that the variable GA  $\leq$  32 weeks was associated with the outcome unplanned catheter removal<sup>(18)</sup>. In our study, this relationship was found, as the prevalence of removed catheters by non-programmed causes in neonates of GA  $\leq$  32 weeks was 65.95%, contrary, this index lowered to 45.90% in NB with GA equal or superior to 32 weeks.

Referring to the non-elective catheter removal, such event in 41.66% of neonates was observed. The most predominant complications for the catheter removal were: infiltration (12.03%), accidental traction (11.11%) and, external rupture (9.25%). The non-elective removal was observed in 39.3% of catheters in a study conducted with 67 neonates, which objective was to describe the prevalence of adverse events. Such result is close to the value found in the present study<sup>(11)</sup>.

Data in the literature points a lower incidence of PICC removal by infiltration (1.2%) and by accidental traction (1.2%), however, in the identified study, there was an incidence of removal by rupture of 9.5%, a value close to what was found in the present study<sup>(11)</sup>. Regarding the catheter removal, the study presented an incidence of 13.04% by rupture, a value higher than what was found in the present study and 4.34% by infiltration, lower value to the one found in the present study<sup>(22)</sup>. When studying 559 newborns that used 626 PICCs, the following complications were present: infiltration (6%), accidental traction (2.4%), and rupture of the external catheter (1.1%). These and other complications represented 48% of the total inserted catheters, a close value to what was found in our study (47.22%)<sup>(23)</sup>.

The main complication responsible for the removal of 12.03% of catheters was the infiltration. In a study conducted with 237 analyzed PICCs, there was a higher infiltration incidence in the group of patients with the catheter tip not located in the central position<sup>(12)</sup>. Possibly, the infiltration occurrence in the present study can be related to the non-central catheter positioning. The complication identification during the opportune time, including the positioning monitoring of the catheter tip (through the registered external measurement) and the observation of phlogistic signals (hyperthermia, edema, pain, loss of function) that can indicate the infiltration presence, can prevent the occurrence of this incident.

Other associated complications to the removal of 11.11% and 9.25% of PICCs were the accidental traction and external rupture, respectively, which are subject to prevention. The unintentional traction can still be related to the inadequate or insufficient fixing of the catheter. Accidental traction prevention includes: continuous

assessment of the access route and dressing integrity; the registration of the catheter external measure at each dressing change; adequate device fixing, as well as the conduction of it, with the help of another professional to guarantee the catheter stability and safety, as in most times the NB gets agitated during dressing changes.

In a study with 45 NBs, 15.4% of PICCs were removed due to external rupture, a value higher than the one found in this study. The inadequate and excessive manipulation should be avoided, as well as the use of syringes with the volume lower than 10 ml to unblock catheters of 1,9 Fr and silicone ones<sup>(9)</sup>. A study conducted with 524 catheters created a risk score for the non-elective removal, which helps to provide more accurate data related to risk to neonate, in the identification of preventive actions for complications during the PICC insertion and permanence<sup>(18)</sup>. The results point the need to create a risk score that represents professional health practices in the studied institution.

Regarding the more severe complications, our study did not identify cardiac tamponade and arrhythmias. Despite 56.48% of inserted PICCs having their tip initially located in the intra-cardiac level. Such fact can be related to the catheter traction procedure conducted after the identification of the intracardiac location, a measure that is taken immediately in cases of clinical repercussion or during the first dressing after 48 hours.

The use of this device has become an integral part and of extreme importance in the assistance to NB. Besides, it is an expansion process in the hospital units. The PICC appears as a fundamental and safe venous access for the intravenous therapeutic of the admitted NB<sup>(24)</sup>.

The adoption of safe care practices is fundamental for the prevention of their complications, and it is indispensable to standardize procedures and overall, to have involvement of all health professionals to offer assistance free of harms to patients, once few complications that favor the non-elective PICC removal can be prevented with specific care. The Patient's Safety National Program aims to contribute to the care qualification in all health establishments and its different acting fields. Which has as some of the leading implementation strategies, the creation and support of protocols for assistance procedures meeting the patient's safety precepts and in the training of professionals in this field<sup>(25)</sup>.

## CONCLUSIONS

The primary indications for non-elective catheter removal were: infiltration, accidental traction, and external rupture. Nursing care for infiltration prevention is the early identification of this complication through monitoring the positioning of the catheter tip and the observation of the presence of phlogistic signs. Regarding accidental traction, it is noted the importance of adequate catheter fixation and use of protocols for the dressing changes. It is vital to avoid the inadequate and excessive manipulation of the device and the use of syringes of volume lower than 10 ml to unblock the catheter, to prevent its rupture.

The nursing team has a fundamental care role in minimizing the causes for non-elective PICC removal, being relevant to note the training and improvement of the professional's ability regarding insertion, maintenance, removal and observation of this device. Additionally, the importance of the correct technique for the antisepsis in its insertion and maintenance, once the neonate skin is delicate and requires more care by the nursing team. Also, the standardization of procedures and nursing routines to use the PICC are contributing factors to reduce



complications as occlusion, overflowing, migration and thrombosis; and to avoid exposing the newborn to new venous catheterization to give continuity to the prescribed medication therapy.

At last, the study brought as impact, the presentation of elements for a reflection and discussion of the nurse practice regarding the causes for non-elective PICC removal, as well as, the need of knowing strategies to prevent the occurrence of complications; which can cause a significantly positive impact in the reduction of costs for the institution, decrease in rates of morbidity and mortality.

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