

PERIPHERALLY INSERTED CENTRAL CATHETER IN NEWBORNS: REMOVAL FACTORS

CATETER CENTRAL DE INSERÇÃO PERIFÉRICA EM RECÉM-NASCIDOS: FATORES DE RETIRADA

CATÉTER CENTRAL INSERTADO PERIFÉRICAMENTE EN RECIÉN NACIDOS: FACTORES DE RETIRADA

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How to cite this article: Mittang BT, Stiegler G, Kroll C, Schultz LF. Peripherally inserted central catheter in newborns: removal factors. Rev baiana enferm. 2020;38:e38387.

Objective: to identify the main factors of removal of the peripherally inserted central catheter in newborns in a neonatal intensive care unit and to verify the association of variables of the newborn and the catheter with the removal factors. **Method:** retrospective, documentary, cross-sectional and quantitative research. The participants were 136 newborns. For the analysis, the Chi-square test was used, adopting a 5% significance level. **Results:** the main factors of removal of the peripherally inserted central catheter were: end of therapy (58.3%), presumed catheter/phlebitis infection (23.5%), accidental disruption/expulsion/difficulty in viewing the catheter tip/others (7.5%), infiltration (6%) and obstruction (6%). There were significant associations between gestational age ($p < 0.001$), number of diagnoses of the newborn ($p = 0.018$), catheter positioning ($p < 0.01$) and the outcome variable factors of peripherally inserted central catheter removal. **Conclusion:** gestational age, number of diagnoses and catheter positioning were the main predictors associated with removal factors.

Descriptors: Infant, Newborn. Neonatal Nursing. Intensive Care, Neonatal. Catheterization, Peripheral.

Objetivo: identificar os principais fatores de retirada do cateter central de inserção periférica em recém-nascidos em unidade de terapia intensiva neonatal e verificar a associação de variáveis do recém-nascido e do cateter com os fatores de retirada. Método: pesquisa retrospectiva, documental, transversal e quantitativa. Participaram 736 recém-nascidos. Para a análise foi utilizado o teste de Qui-quadrado, adotou-se o nível de significância de 5%. Resultados: os principais fatores de retirada do cateter central de inserção periférica foram: término de terapia (58,3%), infecção presumida do cateter/flebite (23,5%), rompimento/expulsão acidental/dificuldade de visualização da ponta do cateter/outros (7,5%), infiltração (6%) e obstrução (6%). Encontradas associações significativas entre a idade gestacional ($p < 0,001$), quantidade de diagnósticos do recém-nascido ($p = 0,018$), posicionamento do cateter ($p < 0,01$) e a variável desfecho fatores de retirada do cateter central de inserção periférica. Conclusão: a idade gestacional, o número de diagnósticos e o posicionamento do cateter foram os principais preditores associados aos fatores de retirada.

Descritores: Recém-nascido. Enfermagem Neonatal. Terapia Intensiva Neonatal. Cateterismo Periférico.

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Objetivo: identificar los principales factores de retirada del catéter central insertado periféricamente en recién nacidos en una unidad de cuidados intensivos neonatales y verificar la asociación de variables del recién nacido y del catéter con los factores de retirada. Método: investigación retrospectiva, documental, transversal y cuantitativa. Los participantes fueron 136 recién nacidos. Para el análisis, se utilizó la prueba chi-cuadrada, y se adoptó el nivel de significancia del 5%. Resultados: los principales factores de retirada del catéter central insertado periféricamente fueron: fin del tratamiento (58,3%), presunta infección por catéter/flebitis (23,5%), interrupción accidental/expulsión/dificultad para ver la punta del catéter/otros (7,5%), infiltración (6%) y obstrucción (6%). Se encontraron asociaciones significativas entre la edad gestacional ($p < 0.001$), el número de diagnósticos del recién nacido ($p = 0.018$), el posicionamiento del catéter ($p < 0.01$) y la variable resultado factores de la retirada del catéter central de inserción periférica. Conclusión: la edad gestacional, el número de diagnósticos y el posicionamiento del catéter fueron los principales predictores asociados con los factores de retirada.

Descriptores: Recién Nacido. Enfermería Neonatal. Cuidado Intensivo, Neonatal. Cateterismo Periférico.

Introduction

The advent of the Peripherally Inserted Central Catheter (PICC) began in 1711, with the studies of the English physiologist Stephen Hales⁽¹⁾. From 1990 onwards, peripherally inserted central catheters began to be used in Brazil and initially prioritized newborns (NB) hospitalized in a neonatal intensive care unit (ICU) due to flexibility and small material diameter⁽²⁾. Since 2001, the nursing professional has been supported by Resolution n. 258 of 2001 of the Federal Nursing Council to insert and manipulate the PICC⁽³⁾, after the qualification and training course. The main institutions that establish guidelines for intravenous therapy are the Infusion Nurses Society (INS) and INS Brazil⁽⁴⁻⁵⁾.

The main indications for PICC use are newborns requiring intravenous therapy for more than six days, use of medications (mainly antibiotics, chemotherapy, blister and hyperosmolar solutions), prolonged parenteral nutrition or other long-term intravenous therapies⁽⁶⁾.

The benefits are the long permanence of the device, reduced occurrence of pneumothorax and hemothorax, lower financial cost than the surgically inserted central venous catheter, reduced number of peripheral venipunctures and, consequently, optimization of the nursing professional's time⁽²⁾. Other benefits are the reduced chances of infection compared to the central venous catheter, protection of the venous network, less harmful insertion, increased time

of use, possibility of administering irritating and/or blister solutions, reduced costs for health services, guarantee of patient safety, in addition to the bedside insertion procedure performed by the nurse⁽⁷⁻¹⁰⁾.

Thus, PICC technology contributes significantly to humanized and specialized care for those who require intravenous therapy, avoiding multiple venipuncture procedures that can potentiate the trauma, stress and pain of the newborn and hospitalized children, in addition to the emotional repercussions also in the family⁽¹¹⁻¹²⁾. Other studies also reinforce the importance of this technology for atraumatic care in neonatology⁽¹³⁻¹⁴⁾.

This intravenous device, although very important to ensure the survival of the newborn and the child, requires, in addition to professional training, specific materials and monitoring. However, it is not free of complications, such as catheter fracture, bloodstream infection, phlebitis, hematomas, poor positioning with risk of infiltration, extravasation, cardiac tamponade and cardiac arrhythmia, which may result in recurrent punctures that facilitate trauma to blood vessels⁽¹⁵⁾. Several literatures bring significant prevalences for non-elective PICC removal. In an Australian study, the prevalence of removal due to complications reached 33.8% of the devices⁽¹⁶⁾. In Brazil, the prevalence is even higher; removal of the device due to complications occurred in 41.66% of the removal cases⁽¹⁷⁾.

The use of the catheter in the neonatal ICU is representative, and nurses play a fundamental role throughout the use process to avoid complications⁽¹⁸⁾. Nurses need to be aware of the reasons that lead to the early removal of the device prior to the end of treatment and, later, to develop and implement expanded care protocols and strategies. Proper, qualified handling and recognition of the signs and symptoms of these alterations are fundamental during the care of the newborn⁽¹⁸⁾.

Another motivator for this research was the absence of studies conducted with newborns who received PICC in the neonatal intensive care unit of a public institution in southern Brazil, using the PICC catheter follow-up form and retrospectively analyzing the data to establish the catheter removal factors.

The guiding questions of this research were: What are the factors for removal of peripherally inserted central catheter in a neonatal unit? What is the relationship between the variables of the neonate using PICC and the catheter variables associated with the factors for device removal? Thus, this study aims to identify the main factors of removal of the peripherally inserted central catheter in newborns in a neonatal intensive care unit and to verify the association of variables related to the newborn and the central catheter with the removal factors.

Method

Retrospective, documentary, cross-sectional study with quantitative approach, developed in a Neonatal Intensive Care Unit of a public maternity hospital in Santa Catarina, Brazil.

The institution aims to provide assistance to the mother, baby and family, and is a reference for the care of high-risk pregnancy and in Neonatal ICU. It has 10 beds for Neonatal ICU, 14 beds for Conventional Neonatal Intermediate Care Unit (CNICU) and 3 beds destined to the Kangaroo Neonatal Intermediate Care Unit (KANICU)⁽¹⁹⁾. The neonatal ICU has a Standard Operating Procedure (SOP) entitled "PICC Insertion", which establishes and standardizes the procedure execution by nursing professionals.

The participants were newborns submitted to PICC insertion procedure during hospitalization in the Neonatal ICU. Inclusion criteria were: newborn who used PICC in the period 2014-2018, with complete documentation form, and completed the "PICC Use Assessment" corresponding to catheter follow-up from insertion to removal. The five-year period was determined based on the number of devices inserted annually. In this time interval, there was a sufficient population sample to be conducted with a reliable study.

The study excluded newborns whose PICC insertion was performed in another institution, those who, after insertion, were transferred to another hospital, those who died during the PICC use period, and those whose device was inserted through phlebotomy.

Data collection occurred between August and September 2019, performed by two previously trained researchers, and there was a double check of the collected data. The study was approved by the Research Ethics Committee (REC) under Opinion n. 3.471.388 and signed the term of feasibility of the study site.

Data were collected from the records made by the nurses in the form entitled "Evaluation of PICC Use", whose purpose is to document, record, monitor and evaluate all newborns with PICC inserted.

For this study, the outcome variable PICC removal factor was used in newborns considering: end of therapy, obstruction, presumed infection/phlebitis, infiltration, and accidental disruption/expulsion/difficulty in viewing the catheter tip/others. The predictor variables analyzed related to the newborn were: gestational age (premature <37 gestational or full-term ≥37 gestational weeks), gender (female or male) and clinical diagnoses (number of diagnoses of prematurity, respiratory distress, hypoglycemia, low output, among others). Regarding the predictor variables related to PICC insertion, the study considered: indications for using the PICC (number of indications with prolonged therapy, difficulty in venipuncture, vasoactive drug, food intolerance and hypertonic solution), insertion site (upper limbs, lower limbs or

head/neck) and catheter positioning (central or peripheral). It is important to emphasize that “clinical diagnoses”, “indications for using PICC” and “removal factor” may contain more than one variable simultaneously.

The variable clinical diagnoses described in the “Evaluation of PICC Use” form by nurses corresponds to that determined by a medical professional in the sector and recorded in the newborn’s medical records.

The collected data was organized and stored in a spreadsheet in the database in the Microsoft Office - Excel® 2016 software. Statistical analysis was performed using the Software Statistical Package for the Social Sciences (SPSS), version 22.0. The normality of the variables was analyzed by the Kolmogorov-Smirnov test. For descriptive analysis, the absolute and relative frequencies, median and interquartile range (IQR) of variables with non-normal distribution were reported. The chi-square test was used to test the association and describe the prevalence of the outcome “catheter removal factors” in relation to categorical predictor variables: gestational age (preterm or full term), gender, number of diagnoses (1 to 2 diagnoses or ≥ 3 diagnoses), number of indications (1 to 2 indications or ≥ 3

indications), PICC insertion site, number of PICC placement attempts (1, 2 or ≥ 3 attempts) and PICC positioning. The results were considered significant when $p < 0.05$.

Results

Between 2014 and 2018, 1,094 PICC were inserted in newborns in the Neonatal Intensive Care Unit. Of these, 70 were excluded from the study by external transfer, 224 due to incomplete form, 46 by death and 18 due to the insertion of phlebotomy by a medical professional, leaving 736 newborns who used the PICC inserted by nurses.

Table 1 shows the characteristics related to the newborn submitted to the PICC passage procedure. The NB had a median gestational age of 33 (IQR 6.0) weeks, birth weight of 1,715 (IQR 1426.2) grams, current weight at the time of the procedure 1,737.5 (IQR 1365.0) grams, and 6 days (IQR 6.0) of hospitalization time. There was a higher prevalence of preterm newborns (76.5%), female (50.3%), diagnosed with prematurity (73.1%), followed by respiratory distress (68.3%), presumed infection (52.2%), low output (12.8%) and others (10.5%).

Table 1 – Characteristics of the newborns with peripherally inserted central catheter at a neonatal intensive care unit. Santa Catarina, Brazil – 2014-2018 (continued)

Characteristics	Absolute Frequency (n)	Relative Frequency (%)	Median	Interquartile Range
Newborn				
Gestational Age (Capurro)			33.0	6.0
Full-Term	173	23.5		
Preterm	563	76.5		
Sex				
Male	366	49.7		
Female	370	50.3		
Birth Weight (grams)			1715.0	1426.2
Current Weight (grams)			1737.5	1365.0
Clinical Diagnoses				
Prematurity	538	73.1		
Respiratory Distress	503	68.3		
Hypoglycemia	39	5.3		
Low Output	94	12.8		

Table 1 – Characteristics of the newborns with peripherally inserted central catheter at a neonatal intensive care unit. Santa Catarina, Brazil – 2014-2018 (conclusion)

Characteristics	Absolute Frequency (n)	Relative Frequency (%)	Median	Interquartile Range
Clinical Diagnoses				
Presumed Infection	384	52.2		
Perinatal Asphyxia	34	4.6		
Seizure	19	2.6		
Others	74	10.5		
Hospitalization Length (days)			6.0	6.0

Source: Created by the authors.

Table 2 describes information regarding the use of PICC in newborns. In 2015, there was a higher prevalence of insertion of this catheter (24.5%), followed by 2014, with 174 (23.6%) procedures. The insertion site with the highest predominance was the upper limbs (81.4%),

and 2-3 puncture attempts were prevalent (41.3%). Regarding catheter positioning, central access was the most prevalently used (90.9%). Regarding the length of catheter permanence in the newborn, the median was 6 days (IQR: 6).

Table 2 – Characteristics of the use of the peripherally inserted central catheter in newborns in a neonatal intensive care unit. Santa Catarina, Brazil – 2014-2018

Characteristics Catheter	Absolute Frequency (n)	Relative Frequency (%)	Median	Interquartile Range
Year				
2014	174	23.6		
2015	180	24.5		
2016	114	15.5		
2017	135	18.3		
2018	133	18.1		
Insertion Site				
Upper limbs	599	81.4		
Lower limbs	111	15.1		
Head and neck	26	3.5		
Number of attempts			2.0	2.0
1	300	40.8		
2-3	304	41.3		
4 or more	132	17.9		
Catheter positioning				
Central	669	90.9		
Peripheral	67	9.1		
Catheter permanence length in the newborn (days)			6.0	6.0

Source: Created by the authors.

The most prevalent PICC removal factor in the newborns was the end of therapy (58.3%), followed by presumed catheter/phlebitis infection (23.5%). Factors such as accidental disruption/expulsion/difficulty in viewing the catheter tip/others, obstruction and infiltration

were the least prevalent (7.5%, 6.0% and 6.0%, respectively).

The association between the predictor variables of the newborn and the PICC catheter with the removal factors of the peripherally inserted central catheter are indicated in Table 3.

Table 3 – Association of newborn variables and peripherally inserted central catheter according to the catheter removal factors in a Neonatal Intensive Care Unit. Santa Catarina, Brazil - 2014-2018

Variables	Catheter removal factors				
	End of therapy	Obstruction	Presumed infection/phlebitis	Infiltration	Breakage/accidental expulsion/difficulty viewing/ other
	n (%)	n (%)	n (%)	n (%)	n (%)
Gestational age					
Full-Term	131 (75.7)	8 (4.6)	21 (12.1)	3 (1.7)	10 (5.8)
Preterm	316 (56.1)	36 (6.4)	147 (26.1)	38 (6.7)	26 (4.6)
Sex					
Female	213 (57.6)	21 (5.7)	96 (25.9)	23 (6.2)	17 (4.6)
Male	234 (63.9)	23 (6.3)	72 (19.7)	18 (4.9)	19 (5.2)
N. of diagnoses					
1-2	273 (62.8)	17 (3.9)	93 (21.4)	29 (6.7)	23 (5.3)
≥3	174 (57.8)	27 (9.0)	75 (24.9)	12 (4.0)	13 (4.3)
N. of indications					
1-2	316 (62.8)	30 (6.0)	106 (21.1)	25 (5.0)	26 (5.2)
≥3	131 (56.2)	14 (6.0)	62 (26.6)	16 (6.9)	10 (4.3)
Insertion site					
Upper limbs	370 (61.8)	34 (5.7)	137 (22.9)	33 (5.5)	25 (4.2)
Lower limbs	58 (52.3)	9 (8.1)	30 (27.0)	5 (4.5)	9 (8.1)
Head/neck	19 (73.1)	1 (3.8)	1 (3.8)	3 (11.5)	2 (7.7)
N. of attempts					
1	165 (55.0)	20 (6.7)	79 (26.3)	16 (5.3)	20 (6.7)
2	195 (64.1)	16 (5.3)	65 (21.4)	15 (4.9)	13 (4.3)
≥3	87 (65.9)	8 (6.1)	24 (18.2)	10 (7.6)	3 (2.3)
Positioning					
Central	409 (61.1)	43 (6.4)	159 (23.8)	27 (4.0)	31 (4.6)
Peripheral	38 (56.7)	1 (1.5)	9 (13.4)	14 (20.9)	5 (7.5)

Source: Created by the authors.

Gestational age was associated with catheter removal factor ($p < 0.001$). The end of therapy was the most frequent reason in full-term newborns (75.7%). In preterm NBs, presumed catheter infection/phlebitis (26.1%), obstruction (6.4%) and infiltration (6.7%) were the most prevalent reasons when compared to full-term NBs.

There was a statistically significant association between the total number of clinical diagnoses of newborns and catheter withdrawal factors ($p = 0.018$); those with 1-2 diagnoses had a higher prevalence of end of therapy as a reason for PICC removal (62.8%) when compared to those with ≥ 3 diagnoses (57.8%). The number of clinical

diagnoses may influence the PICC catheter removal factor. NBs with ≥ 3 clinical diagnoses have a higher prevalence of catheter withdrawal factors such as obstruction (9.0%) and presumed infection/phlebitis (24.9%) compared to those with 1-2 diagnoses (3.9% and 21.4%, respectively).

Catheter positioning was also significantly associated with removal factors ($p < 0.001$). Related to the central positioning of the catheter, there was a higher proportion of end of therapy as a reason for PICC removal (61.1%) with a higher prevalence of obstruction (6.4%), presumed infection/phlebitis (23.8%) and lower infiltration and disruption/accidental expulsion/difficulty of visualization/others (4.6%) when compared to PICC peripherally positioned (1.5%, 13.4% and 7.5%, respectively). Another relevant result showed that, when PICC is peripherally positioned, there is a higher prevalence of infiltration (20.9%) when compared to the centrally positioned catheter (4.0%).

Discussion

In this study, the most prevalent PICC removal factor in the newborns was the end of therapy (58.3%), followed by presumed catheter infection/phlebitis (23.5%), accidental disruption/expulsion/difficulty in viewing the catheter tip/others (7.5%), obstruction (6.0%), and infiltration (6.0%).

Furthermore, there was a statistically significant association between gestational age, the number of diagnoses identified and PICC positioning with the catheter removal factor. The end of therapy, as a catheter removal factor, was more prevalent in full-term NBs, with a lower number of clinical diagnoses (1-2) and with central catheter positioning. On the other hand, other factors such as obstruction, presumed infection/phlebitis or infiltration are more prevalent in preterm NB, with a higher number of diagnoses and peripheral catheter positioning.

Regarding the variable gestational age and the catheter removal factor, there are similar results found, which mention that preterm or low birth weight newborns are more susceptible

to nosocomial infections due to immaturity of tissues and organs and the low functioning of the immune system. Consequently, prematurity is a risk factor for the occurrence of certain complications that cause non-elective removal of PICC⁽²⁰⁻²¹⁾.

Studies describe that prematurity is one of the main factors for the onset of transient metabolic and hydroelectrolytic disorders as a result of immaturity of the systems, resulting in a large amount of infused solutions, time of permanence of the device and increased susceptibility to blood infection^(17,22).

The number of clinical diagnoses in this study was associated with the PICC catheter removal factor, in which NB with ≥ 3 clinical diagnoses have a higher prevalence in catheter removal factors such as obstruction and presumed infection/phlebitis when compared to Newborns with 1-2 diagnoses. Studies relate prematurity to the number of disorders, resulting in a propensity for blood infection due to the amount of solutions infused, greater catheter manipulation and longer length of stay^(17,21).

The upper limbs are the places of greatest choice for the insertion of PICC due to the greater ease of progression and centralization, a result also found in this study⁽¹⁷⁾. The study conducted in the United States of America converges with the findings of this research, which points out that the insertion of PICC in the lower limbs leads to a higher occurrence of phlebitis⁽²³⁾.

A study in Greece verified the relationship between the PICC insertion site with complications during its use, however, there was no association between the number of attempts to insert the catheter and the length of stay of the PICC⁽²⁴⁾.

As for the results of this research related to catheter positioning with the removal factors, they are in agreement with the findings of other authors, such as the one that analyzed that, when the tip of the PICC catheter was not in the central position, the risk of being removed was twice as high⁽²²⁾. Infiltration was also identified as the main complication when the device is peripherally located⁽¹⁷⁾.

Based on the knowledge of the PICC removal factors, it is possible to implement safe nursing practices and standardize procedures to achieve the end of intravenous therapy and prevent its complications, ensuring the safety of the newborn⁽¹⁷⁾. The National Patient Safety Program, developed by the Ministry of Health, aims to contribute to the qualification of care, through the adoption of strategies, such as training of professionals, support for implementation and the elaboration of SOP aimed at patient safety⁽²⁵⁾.

A positive point of this research that stands out is the double check throughout the collection, organization and processing of the data. The cross-sectional collection of data over a period of five years with a significant sample allowed a statistical analysis of data association, being relevant for determining the relationship between predictor variables and outcome, contributing to the representativeness of the study nationally, because limited studies present this period of evaluation of the reasons for removal of PICC in the Neonatal Intensive Care Unit.

As a limitation of this study, there stands out the high number of "Evaluation of PICC Use" forms that were excluded from the study for being incomplete and description of the diagnosis as presumed infection and low output that do not fit any classification, although they are used in clinical practice in neonatology. Gaps in the literature related to the following variables are also pointed out: sex of the newborn and total number of indications for the insertion of PICC with the catheter removal factors that completed the discussion.

Conclusion

This research allowed identifying the main factors of removing Peripherally Inserted Central Catheter in newborns from a Neonatal ICU, as well as identifying and associating the variables of the newborn and the catheter with the PICC removal factor variable. The PICC removal factor in the most prevalent newborns was the end of therapy (58.3%), followed by presumed catheter/phlebitis infection (23.5%). Gestational age,

number of diagnoses and PICC positioning were the main predictors associated with catheter removal factors.

This study might also contribute to the planning, monitoring and elaboration of strategies for maintaining this type of catheter until the end of intravenous therapy in newborns in a neonatal intensive care unit.

Collaborations:

1 – conception, design, analysis and interpretation of data: Bruno Tiago Mittag, Gabrieli Stiegler, Caroline Kroll and Lidiane Ferreira Schultz;

2 – writing of the article and relevant critical review of the intellectual content: Bruno Tiago Mittag, Gabrieli Stiegler, Caroline Kroll and Lidiane Ferreira Schultz;

3 – final approval of the version to be published: Bruno Tiago Mittag, Gabrieli Stiegler, Caroline Kroll and Lidiane Ferreira Schultz.

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Received: August 13, 2020

Approved: September 14, 2020

Published: October 22, 2020



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