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RESEARCH

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## Practice of Insertion, Maintenance and Removal of Peripheral Inserted Central Catheter in Neonates

Práticas de Inserção, Manutenção e Remoção do Cateter Central de Inserção Periférica em Neonatos

Practice of Insertion, Maintenance and Removal of Peripheral Inserted Central Catheter in Neonates

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### ABSTRACT

**Objective:** The study's purpose has been to assess nursing practices regarding the insertion, maintenance and removal of Peripherally Inserted Central Catheter in neonates. **Methods:** It is a retrospective study that was carried out in a University Hospital with a sample of 137 newborns over the period from 2009 to 2012. Data were collected from medical records and analyzed with statistical tests. **Results:** The initial positioning of the tip of the catheter was central in 60.6%. There were complications in 53.3% of catheters, and the most common of those were as follows: obstruction (13.1%), infiltration and/or overflow (12.4%). The catheter's permanence time was influenced ( $p < 0.05$ ) by the non-central positioning of the tip, complications, and the non-elective removal. **Conclusion:** It is important to highlight the need for creating both protocols and educative intervention programs in order to guarantee the patient's safety, and also the assistance quality.

**Descriptors:** Central Venous Catheterization, Peripheral Catheterization, Neonatal Intensive Care Unit, Newborn, Nursing.

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## RESUMO

**Objetivo:** Avaliar as práticas de enfermagem na inserção, manutenção e remoção do Cateter Central de Inserção Periférica em neonatos. **Métodos:** Estudo correlacional retrospectivo realizado em um Hospital Universitário com amostra de 137 neonatos no período de 2009 a 2012. Os dados foram coletados no prontuário e analisados com testes estatísticos. **Resultados:** O posicionamento inicial da ponta do cateter foi central em 60,6%. Complicações ocorreram em 53,3% dos cateteres, e as mais comuns: obstrução (13,1%) e infiltração/extravasamento (12,4%). O tempo de permanência foi influenciado ( $p < 0,05$ ) pela posição da ponta não central, complicações e remoção não eletiva. **Conclusão:** Destaca-se a necessidade de elaboração de protocolos e a realização de programas de intervenção educativa, a fim de garantir a segurança do paciente e a qualidade da assistência.

**Descritores:** Cateterismo Venoso Central, Cateterismo Periférico, Unidades de Terapia Intensiva Neonatal, Recém-Nascido, Enfermagem.

## RESUMEN

**Objetivo:** Evaluar las prácticas de enfermería en la inserción, mantenimiento y retirada de catéter central de inserción periférica en los recién nacidos. **Métodos:** Estudio correlacional retrospectivo realizado en un hospital universitario con una muestra de 137 recién nacidos en el período de 2009 a 2012. Los datos fueron recogidos de las historias clínicas y se analizaron con pruebas estadísticas. **Resultados:** La colocación inicial de la punta del catéter fue central en el 60,6%. Las complicaciones ocurrieron en el 53,3%, y las más comunes: obstrucción (13,1%) y la infiltración/extravasación (12,4%). El tiempo de permanencia fue influenciado ( $p < 0,05$ ) por posición de la punta no central, las complicaciones y la eliminación no electiva. **Conclusión:** Se destacó la necesidad de desarrollo de protocolos y la realización de un programa de intervención educativa con el fin de garantizar la seguridad del paciente y la calidad de la atención.

**Descriptores:** Cateterismo Venoso Central, Cateterismo Periférico, Unidades de Terapia Intensiva Neonatal, Recién Nacido, Enfermería.

## INTRODUCTION

Intravenous therapy is one of the areas that has demanded attention from nursing care in Neonatology due to the constant need for safe and long-term venous access for administration of antibiotics, venous hydration, parenteral nutrition, vasoactive drugs, among others.<sup>1</sup>

A stable and effective venous access alternative for critically ill neonates in the Neonatal Intensive Care Unit (NICU) is the Peripherally Inserted Central Catheter (PICC), a long, flexible catheter, inserted through a peripheral vein, progresses to the distal third of the superior vena cava or inferior vena cava, thus acquiring properties of central venous access.<sup>2-3</sup>

In Brazil, PICC began to be used in the 1990s and is increasingly used, especially in newborn (NB), because it has the advantages, as follows: staying for a prolonged period, having no vascular injury, being inserted at the bedside, have a lower risk of infection compared to other central vascular devices, improve drug hemodilution, minimize invasive procedures, stress and discomfort of the neonate.<sup>4-5</sup>

The disadvantages of using the PICC are that it requires special training for insertion and maintenance of the device,

requires access to calibrated and intact veins, radiography to visualize the location of the catheter tip, and strict surveillance due to the risks involved in using this device, which is associated with some complications that may occur during insertion, maintenance and removal.<sup>3,6</sup>

The main complications related to PICC are phlebitis, infusion extravasation, infection, thrombosis, premature dislocation, sepsis, embolism, occlusion and rupture, and are known to occur less frequently than other centrally located catheters, but deserve special attention by professionals responsible for the indication and use.<sup>3-5</sup>

Rigorous surveillance of PICC use is essential for patient safety, which is the most critical and decisive quality dimension, since it corresponds to minimizing the risk of unnecessary harm associated with health care to the minimum acceptable.<sup>7</sup>

In addition to the theoretical background and technical skills that support the promotion of effective assistance results in the insertion and maintenance of the PICC, also legal protection is required. In this sense, the Federal Nursing Council in Brazil through the Resolution No. 258/2001 defines the insertion and maintenance of the PICC as a technical and legal competence for a nurse duly qualified and/or professionally qualified for such procedure.<sup>8</sup>

Given the aforementioned, this research aims to assess nursing practices regarding the insertion, maintenance and removal of PICC in neonates, since it may contribute to the diagnosis of the reality and the adoption of behaviors that imply in the improvement of nursing care to NB who use it, considering that the production of scientific knowledge about this practice can contribute to the development and incorporation of strategies that minimize risks in care, and also contribute to patient safety and to the reduction of neonatal morbidity and mortality.

## METHODS

It is a retrospective study with a quantitative approach that was performed through the analysis of secondary data of the NICU from a University Hospital, composed of 18 beds, the nursing team consists of 10 nurses, and 07 are trained to insert the PICC, and 45 technicians and nursing assistants. Indication of catheter use and removal occurs in agreement with the medical team. The insertion of the catheter is performed mainly by qualified nurses, including patient preparation, asepsis, venous puncture with short catheter under needle, intravenous progression and verification of the positioning of the tip in radiological image for its release. All follow-up is recorded on the PICC follow-up sheet, which includes catheter insertion, maintenance and removal data.

The sources of information were NB records and the PICC records for the years 2009, 2011 and 2012. The exclusion criteria were as follows: records of NB admitted from another institution with the catheter already inserted; NB

transferred to another institution with the catheter installed; NB who died while using the catheter; NB who had the insertion of the PICC by another professional, not nurse; and the accompanying sheets of the 2<sup>nd</sup> and 3<sup>rd</sup> PICC inserted in a single NB.

A total of 197 records of PICC were registered in 169 neonates during the period considered. After applying the exclusion criteria, the data concerning the 137 neonates and the PICC use were then analyzed. A data collection tool constructed by the researcher was used from the PICC data sheet, composed of 4 parts: (1) characterization of the NB; (2) description of the insertion procedure; (3) maintenance description and (4) removal description.

Descriptive analyzes of percentage (qualitative variables), averages and standard deviations (quantitative variables) were performed. Student's t-test (two categories) and ANOVA (more than two categories) were used to compare the catheter average permanence time, according to study variables. The level of significance was 5%.

This study was approved by both the Institution and the Research Ethics Committee from the Health Sciences Center/*Universidade Federal do Espírito Santo*, under the Legal Opinion No. 282,879 with report date on 05/22/13.

## RESULTS AND DISCUSSION

Considering the newborns' characterization (Table 1), there was a predominance of newborns (51.1%), who were born with gestational age between 28 and 36.6% (93%), with a average of 31.1 weeks (SD: 3.9, the minimum was 24.5 and the maximum 41.1), the weight between 1,000 and 1,499 g (35%), and below 1,000 g (32.1%), suitable for gestational age (67.9%), where the main diagnosis was the prematurity (87.6%).

**Table 1** – Characterization of neonates using the PICC. *Vitória, Espírito Santo, Brazil.*

Variable	n	%
<b>Sex</b>		
Male	67	48.9
Female	70	51.1
<b>Gestational age (GA, in weeks)</b>		
<28	29	21.1
28-36.6	93	67.9
≥37	15	11
<b>Birth weight (g)</b>		
<1,000	44	32.1
1,000 - 1,499	48	35
1,500 - 2,499	34	24.9
≥2,500	11	8
<b>Classification GA x Weight</b>		
Suitable for gestational age	93	67.9
Small for gestational age	43	31.4

Great for gestational age	1	0.7
<b>Main Diagnosis</b>		
Prematurity	120	87.6
Gastrointestinal disorder	7	5.1
Sepsis	3	2.1
Asphyxia	2	1.5
Hypoglycemia	2	1.5
Nephropathy	2	1.5
Cardiopathy	1	0.7

With regards to the characterization of the neonates still, in relation to the variables gestational age, birth weight and clinical diagnosis of hospitalization, the results found in this study corroborate with that described in the literature,<sup>3-4,7,9</sup> since the NICU researched is linked to the referral maternity from a university hospital and has high risk gestation cases.

Prematurity is one of the main clinical diagnoses of hospitalization in the neonatal units, responsible for high rates of morbidity and mortality in the perinatal period, since they require exogenous contribution to the performance of their physiological processes.<sup>7,10</sup>

Concerning the nursing practices for the PICC insertion, the characteristics of the procedure were observed (Table 2 and 3). Indications for catheter use were mainly for intravenous therapy for a period longer than 6 days (74.5%), The insertion occurred in the neonate between 4 and 7 days of life (39.4%) and with up to 3 days of life (36.5%) predominantly, with weight at the day of insertion less than 1,000 g (35.8%) and also between 1,000 and 1,499 g (35.8%).

The most used type of catheter was the 1.9 Fr monolumen silicone (88.3%), and the success of the insertion occurred until the forth puncture attempt (73.7%), where the cephalic and basilic veins were the more frequently punctured (41.6%) and (32.1%), respectively. No interurrences were observed in 73.7% of the insertion procedures, and the most frequent was the inadequate catheter trajectory (10.2%). The most commonly used analgesic was fentanyl hydrochloride (48.9%), followed by IV tramadol (22.6%).

In this study, the initial location of the catheter tip, identified by radiological imaging, was mostly central (60.3%); nonetheless, only 34.3% were in the superior vena cava and 26.3% in the atrium or ventricle. 38% of the catheters needed to be pinched prior to release.

**Table 2** – Description of the characteristics of the PICC insertion procedure. *Vitória, Espírito Santo, Brazil.*

Insertion characteristics	n	%
<b>Indication</b>		
IVT* for more than 6 days	102	74.5
Central access	4	2.9
Both accesses	31	22.6
<b>Weight on insertion day (g)</b>		
<1,000	49	35.8
1,000 - 1,499	49	35.8

1,500 - 2,499	27	19.7
≥2,500	12	8.7
<b>Postnatal age (days)</b>		
≤= 3	50	36.5
4-7	54	39.4
8+	33	24.1
<b>Type of catheter</b>		
1,0 Fr monolumen polyurethane	9	6.6
1,9 Fr monolumen silicone	121	88.3
2,0 Fr duplolumen polyurethane	7	5.1
<b>Analgesic/Sedation</b>		
IV Fentanyl	67	48.9
IV Tramadol	31	22.6
PO Tramadol	17	12.4
IV Midazolam	6	4.4
Nasal Midazolam	3	2.2
Non-nutritive sucking	2	1.5
Not used	11	8
<b>Puncture attempts</b>		
≤= 4	101	73.7
5 or +	34	24.8
No registry	2	1.5
<b>Venous access</b>		
Cephalic	57	41.6
Basilic	44	32.1
Axillary	13	9.5
Medium cubital	4	2.9
Jugular	3	2.2
Temporal	2	1.5
Femoral	1	0.7
No records	13	9.5

**\*IVT: Intravenous Therapy**

**Table 3** – . Description of the characteristics of the PICC insertion procedure. Vitória, Espírito Santo, Brazil

Insertion characteristics	n	%
<b>Complications</b>		
Inadequate path	14	10.2
Bleeding	11	8
Non-total catheter progression	10	7.3
Vessels rupture	1	0.7
There was no complication	101	73.7
<b>Location of the PICC tip</b>		
Central	81	60.6
Not central	46	33.6
No records	8	5.8
<b>Venous location of the PICC tip</b>		
Upper vena cava	47	34.3
Subclavian	35	25.5
Right atrium	26	19
Right ventricle	10	7.3
Jugular	5	3.7
Axillary	5	3.7
Liver	1	0.7
No records	8	5.8
<b>Conduct</b>		

Release	83	60.6
Traction and release	52	38
No records	2	1.5

Regarding the nursing practices for the PICC insertion, this is indicated for neonates using venous hydration, antibiotic therapy, parenteral nutrition, glucose infusion above 12.5% and infusion of vasoactive amines,<sup>4-5,10-11</sup> which justifies the use of this device by the subjects of this study, who require long-term intravenous therapy. The type of catheter most used is in agreement with the literature, being the most indicated for the characteristics of weight and age of the NB in relation to the caliber and lower incidence of thrombophlebitis in relation to the material.<sup>1,7,12</sup>

Although the success of the insertion occurred until the forth puncture attempt in most cases, it is worth mentioning that many NBs suffered multiple punctures, and as recommended by the Infusion Nurses Society (INS), the maximum number of punctures per professional is two.<sup>1</sup> Multiple punctures increase the chances of infection<sup>5</sup> and greater exposure to pain that can cause long-term deleterious effects on neurological and behavioral development.<sup>10,12-13</sup>

The most frequently punctured veins were cephalic and basilic, which are the most recommended because of their greater caliber, smaller numbers of valves and easier manipulation in the insertion procedure and also in the dressing exchange.<sup>5,7,10</sup>

It was evidenced the use of analgesic in most NB during insertion nursing practices, which is justified by the need to adopt pharmacological or non-pharmacological measures that reduce pain caused by the invasive and painful insertion of the PICC.<sup>11-13</sup>

Concerning the position of the catheter tip, its adequate location is essential for the prevention of complications: it should be located in the superior vena cava or inferior vena cava, near the junction with the right atrium, 0.5 to 1 cm outside the cardiac chamber to NBs.<sup>14-16</sup> The data found in this study demonstrate that, in the initial position of the majority, although central, they were not in the ideal position, requiring intervention. Some authors report values for the central position above that found in this study, in relation to the tip position.<sup>2,9</sup> It is worth noting that the professionals of the research unit do not use standardization to determine the position of the tip, therefore, this classification can occur subjectively.

Considering the nursing practices for maintenance and removal of the PICC, the characteristics of these procedures are presented in **Table 4**.

The frequency of dressing replacement was up to 3 times in 72.3% of the neonates; the main drugs infused in the same PICC were venous hydration, antibiotics and parenteral nutrition (65%). The occurrence of complications was 53.3%, and the most frequent obstruction in this study occurred in 13.1% of the catheters.

In this study we chose to present the infiltration and extravasation values together (12.4%), as confusion regarding the definitions of these terms was observed in the reports of the catheter follow-up sheets performed by the nurses of the unit investigated.

In this study the mean length of stay was 10.6 (standard deviation: 6.3; minimum time of 0 and maximum of 30). Regarding the reasons for removal, 56.2% were elective, in other words, at the therapy end, another 12.4% due to infiltration/extravasation, and 8.8% due to accidental exteriorization.

Only 9 (6.6%) catheter tips were sent to culture, and the results were positive in 5 (3.6%). The microorganisms found were as follows: *Candida albicans*, *Candida sp.*, *Staphylococcus capitis-capitis*, *Enterobacter cloacae*, *Staphylococcus epidermidis*.

**Table 4** – Description of the characteristics of the PICC maintenance and removal procedures. *Vitória, Espirito*.

Maintenance characteristics	n	%	Removal characteristics	n	%
<b>Frequency of curative changing procedure</b>			<b>Permanence time</b>		
≤ 3	99	72.3	≤ 5	27	19.7
4-7	35	25.5	6-10	51	37.2
8-	3	2.2	11-15	32	23.4
<b>Medicines</b>			16-	24	17.5
VH-PN-AT	89	65	No records	3	2.2
VH-PN-AT-VAD	32	23.4	<b>Reason for removal</b>		
VH-AT	8	5.8	Elective	77	56.2
VH-PN	7	5.1	Non elective	57	41.6
VH	1	0.7	No records	3	2.2
<b>Complications</b>			<b>Reason description</b>		
There was no complication	64	46.7	Termination of therapy	77	56.2
Obstruction	18	13.1	Infiltration Extravasation	17	12.4
Infiltration Extravasation	17	12.4	Accidental exteriorization	12	8.8
Externalization	12	8.7	Obstruction	6	4.4
Sepsis fungal	6	4.4	Sepsis fungal	6	4.4
CRBI	5	3.7	CRBI	5	3.6
Rupture	5	3.7	Break	5	3.6
Accidental traction	5	3.7	Accidental draw	5	3.6
Phlebitis	4	2.9	Acrocyanosis	1	0.7
Acrocyanosis	1	0.7	No records	3	2.2
			<b>Tip culture performed</b>		
			No	124	90.5
			Yes	9	6.6
			No records	4	2.9
			<b>Culture Result</b>		
			Unrealized	124	90.5
			Positive	5	3.6
			Negative	2	1.5
			No return from the laboratory	2	1.5
			No records	4	2.9

**VH: Venous Hydration; PN: Parenteral Nutrition; AT: Antibiotic Therapy; VAD: Vasoactive Drugs; CRBI: Catheter-related bloodstream infection.**

About the nursing practices for maintenance and removal of the PICC, it was verified that the occurrence of complications was similar to the results found in the literature, which ranges from 30.7% to 62.2%.<sup>12-13,17-18</sup> The

PICC obstruction was one of the most frequent complications in this study, compatible with the range of values of 6.9 to 25% reported by other authors.<sup>4,13,17-19</sup>

Herein, it has been chosen to present infiltration and extravasation values together, since there was confusion regarding the definitions of these terms in the reports of the catheter monitoring records performed by the nurses of the study unit, which results of other studies, which did not contain the two variables. The occurrence of rupture was lower than that reported in the literature that ranged from 7.1 to 15.4%.<sup>4,9,17-19</sup> Furthermore, the results of the positive tip cultures demonstrate a low occurrence in relation to other studies, which vary from 10 to 26%.<sup>18,20</sup>

The PICC is a long-term central venous catheter, with indication for therapies above six days, but its maximum time of stay is still unclear. The INS, one of the most respected infusion therapy entities in the world, recommends a maximum time of one year.<sup>1,7</sup> In nursing practices for maintenance and removal of the PICC, mean length of stay was similar to the averages reported in the literature that varied from 7.7 to 14.5 days.<sup>4,6,9</sup>

In the comparisons of the catheter average permanence time, with some variables, presented in **Table 5**, the results indicate statistically significant shorter permanence time for non-central point position (p=0.001), complications (p=0.014) and non-elective removal (p=0.005).

**Table 5** – Descriptive statistics (average and standard deviation) and test results of averages for the catheter permanence time according to the variables. *Vitória, Espirito Santo, Brazil*.

Variable	Category	n	Average	SD	p-value
Sex	Male	67	10.97	6.33	0.556*
	Female	68	10.32	6.41	
Intercurrent insertion	Yes	36	9.33	4.28	0.076*
	No	99	11.12	6.92	
Position of the tip	Central	82	12.02	6.74	0.001*
	Not central	43	8.37	5.22	
Complications in maintenance	Yes	68	9.32	5.94	0.014*
	No	66	12.02	6.57	
Reason for Removal	Elective	77	11.96	6.26	0.005*
	Non elective	57	8.88	6.16	
Conduct	Release	82	10.38	6.61	0.472*
	Traction and release	51	11.2	5.91	
Vein	Basilic	44	10.18	5.79	0.491**
	Cephalic	56	10.27	6.54	
	Axillary	22	12	6.63	

\* p-value from the Student's t-test. \*\*p-value from the ANOVA test.

The association of the removal reasons with the PICC tip position, using the Chi-square Test, indicate that 82.4% of the removals due to infiltration and/or leaking complications, and 66.7% central. Considering the removals at the therapy end, PICCs were mostly in the central position (78.9%) and all catheters removed by obstruction were centrally located.

Nevertheless, during the averages comparisons, for some variables, the results indicate statistically significant shorter permanence time for non-central-tip position, complications, and non-elective removal. The occurrence of elective removal found in this study is below that reported in the literature, ranging from 63.8 to 88.5%.<sup>3,5,9,20</sup> These data suggest inadequate PICC management practices, compromising patient safety and the maintenance of the proposed infusion therapy.

## CONCLUSIONS

This study evaluated the nursing practices regarding the insertion, maintenance and removal of PICC from a NICU during a three-year period, which has provided knowledge about the state of use of the device and the population that received it. The study also aimed to contribute to the reflection and adoption of behaviors that implies the improvement of nursing care towards the NB, and also directs the teaching about nursing care required for insertion, maintenance and removal of the PICC.

The characteristics found in this research are similar to those reported in the literature. Nonetheless, some issues that need reassessment have been highlighted. One of them is the initial misalignment of the catheter tip, both in non-central sites and in the central sites, when they go beyond what is necessary, and they also require traction maneuvers for repositioning. This data indicates a need for revision of the catheter insertion and measurement technique, or even the implementation of technologies that promote adequate positioning.

There were also a large number of complications that led to the non-elective removal of the PICC. In order to reduce the occurrences that compromise the permanence of the catheter, it is required the training and the permanent education of the professionals, aiming to develop knowledge, skill and ability to handle the PICC. It is worth emphasizing that changes in the composition of the nursing team and professionals in the training phase may be factors of inadequate handling of the catheter.

Some of the study limitations were as follows: the lack of standardization in catheter tip position ratings and the non-existence of definition of terms for the records. Nevertheless, these limitations are due to any studies that use documentary data and that have their own data source, without the possibility of total control of the variables by the researcher.

Protocols and routines are proposed for the actions standardization and records compliance during the PICC use, and also the implementation of an educational intervention program, aiming to offer improvement and training to the team, then contributing to better patient safety and nursing care quality.

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