Cogitare Enfermagem
ISSN: 1414-8536
ISSN: 2176-9133
Universidade Federal do Paraná

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CATETER CENTRAL DE INSERÇÃO PERIFÉRICA: MOTIVOS DE REMOÇÃO NÃO ELETIVA E CUSTO DO CONSUMO MENSAL*

Cogitare Enfermagem, vol. 23, núm. 4, e57498, 2018
Universidade Federal do Paraná

DOI: https://doi.org/10.5380/ce.v23i4.57498

Disponível em: https://www.redalyc.org/articulo.oa?id=483660655011

Original article

PERIPHERALLY INSERTED CENTRAL CATHETER: REASONS FOR NON-ELECTIVE REMOVAL AND MONTHLY COST OF CONSUMPTION*

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ABSTRACT: Objective: to analyze the non-elective removal of a peripherally inserted central catheter in a Pediatric and Neonatal Intensive Care Unit and to identify the mean monthly cost of the consumption of these catheters. Method: quantitative, retrospective study carried out in a public teaching and research hospital. The records related to 101 catheter insertions were descriptively analyzed in 2016. To help in the costing, the unit costs of the catheters were obtained from the Purchasing and Warehousing Sector of the hospital. Results: among the reasons for non-elective removal of 40 (100%) catheters, infection/sepsis (22.5%); obstructions (20.0%); and ruptures of the external portion of the catheter (20.0%) were highlighted. The cost of consumption of 110 catheters was US$12,915.67 and the mean monthly direct cost was US$1,291.57. Conclusion: to identify the reasons for non-elective removal of these catheters and the cost of their consumption can help the nurse in the decision-making process in relation to the rational and effective use of these devices.
DESCRIPTORS: Intensive care units; Critical care nursing; Vascular access devices; Costs and cost analysis; Pediatric Nursing.

CATETER CENTRAL DE INSERÇÃO PERIFÉRICA: MOTIVOS DE REMOÇÃO NÃO ELETIVA E CUSTO DO CONSUMO MENSAL

RESUMO: Objetivo: analisar a remoção não eletiva de cateter central de inserção periférica em Unidade de Terapia Intensiva Pediátrica e Neonatal e identificar o custo médio mensal do consumo destes cateteres. Método: pesquisa quantitativa, retrospectiva, realizada em um hospital público de ensino e pesquisa. Foram analisados descritivamente os registros relativos a 101 passagens desses cateteres em 2016. Para subsidiar o custeio, obtiveram-se os custos unitários dos cateteres junto ao Setor de Compras e Almoxarifado do hospital. Resultados: dentre os motivos de retirada não eletiva de 40 (100%) cateteres destacaram-se infecção/sepse (22,50%); obstruções (20%) e rupturas da porção externa do cateter (20%). O custo do consumo de 110 cateteres correspondeu a US$12,915.67 e o custo direto médio mensal a US$1,291.57. Conclusão: conhecer os motivos de remoção não eletiva desses cateteres e o custo do seu consumo pode auxiliar o enfermeiro no processo decisório quanto ao uso racional e efetivo desses dispositivos.
DESCRITORES: Unidades de terapia intensiva; Enfermagem de cuidados críticos; Dispositivos de acesso vascular; Custos e análise de custo; Enfermagem Pediátrica.

CATÉTER CENTRAL DE INSERCIÓN PERIFÉRICA: MOTIVOS DE REMOCIÓN NO ELECTIVA Y COSTO DEL CONSUMO MENSUAL

RESUMEN: Objetivo: Analizar la remoción no electiva de catéter central de inserción periférica en Unidad de Terapia Intensiva Pediátrica y Neonatal, identificar costo mensual promedio del consumo de estos catéteres. Método: Investigación cualitativa, retrospectiva, realizada en hospital público de enseñanza e investigación. Se analizaron descriptivamente registros del pasaje de 101 catéteres durante 2016. Costeo calculado mediante costos unitarios de los catéteres informado por Sector de Compras y Almacenamiento del hospital. Resultados: Fueron motivos mayoritarios de remoción no electiva de 40 (100%) catéteres: infección/sepsis (22,50%); obstrucciones (20%) y roturas en la sección exterior del catéter (20%). El costo del consumo de 110 catéteres fue de USD 12.915,67, y el costo directo mensual promedio fue de USD 1.291,57. Conclusión: Conocer las razones de remoción no electiva de estos catéteres y su costo de consumo puede ayudar al enfermero en el proceso decisorio respecto del uso racional y efectivo de tales dispositivos.
DESCRIPTORES: Unidades de Cuidados Intensivos; Enfermería de Cuidados Críticos; Dispositivos de Acceso Vascular; Costos y Análisis de Costo; Enfermería Pediátrica.

*Article derived from the Master's thesis "Direct Cost of Peripherally Inserted Central Catheter (PICC) Performed by Nurses in Pediatric and Neonatal Intensive Care Unit". University of São Paulo, 2017.

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Received: 20/01/2018
Finalized: 06/09/2018

http://dx.doi.org/10.5380/ce.v23i4.57498

INTRODUCTION

In the Brazilian hospital organizations, the growing use of the peripherally inserted central catheter (PICC) to establish efficient central venous access for intravenous therapy (IVT) has been observed[1-2].

The PICC has been widely indicated in Neonatal Intensive Care Units (NICUs), especially for preterm and low birth weight newborns (NBs) with fragile venous networks[3]. This type of central venous access is suitable for prolonged IVT, characterizing it as a long-term device[4].

Unlike the central venous catheter, the PICC guarantees less traumatic insertions, greater availability of sites for the venous puncture and less chance of accidents, such as pneumothorax and hemothorax, and contamination at its entry site. When compared to peripheral venous access, it offers lower risks for chemical phlebitis, extravasations and infiltrations; it increases blood flow and hemodilution in calibrous veins; it shows greater reliability of access, it provides reduced stress caused by multiple venipunctures and excessive manipulation, it can remain in place for longer and it favors the preservation of the peripheral venous network[1,5-7].

In Brazil, considering the nursing professionals' performance, the PICC insertion is an action only performed by qualified nurses. Resolution No. 258/2001 of the Federal Nursing Council confers on the qualified and/or professionally trained nurse the technical and legal jurisdiction to insert this device[8]. However, in addition to the suitably qualified nurse, the PICC requires the consumption of specific materials, including the catheter and its introducer, sterile fields, transparent film and sterile adhesive strips to protect the insertion site.

The nurses of the Pediatric and Neonatal Intensive Care Unit (PNICU) of a public teaching and research hospital (PTRH) have frequently performed PICC insertion. In 2014, according to data obtained from instruments called "PICC Monitoring", 140 PICCs were inserted in this PNICU and only 57 remained until the end of the IVT. A total of 21 devices were non-electively removed due to obstructions; 12 due to disruptions; 8 because they were externalized; 6 due to physician's order; 6 because of phlebitis/infection; 4 for other causes; 3 due to death; and 1 due to cardiac tamponade. The reasons, which could have been elective or non-elective, for the withdrawal of 22 PICCs were not documented.

In order to provide hospital care, nursing professionals use diverse material resources. Therefore, in addition to the concern with the minimum conditions that provide safety to the patient and themselves, they must be alert to the possibilities of eliminating waste and minimizing costs without compromising the quality standards demanded by updated scientific evidence[9].

In a teaching hospital, the PICC was classified as a high-cost material, with its use being restricted to the critical and semi-critical pediatric units due to the impact on hospital costs. The consumption of 85 devices corresponded to R$16,210.00, representing 8.5% of the total value of R$189,600.00 (monthly mean of R$15,800.00) worth of materials consumed in these units. It should be noted that, in order to determine the consumption and expenditure of materials of complex units, it is the responsibility of the nurse to know the profile of the population, the type of care and the therapeutic approaches necessary[10].

Considering the above, there is an evident need to generate knowledge that can help nurses in the decision-making process regarding the allocative efficiency of material resources, especially those classified as high-cost, such as the PICC. From this perspective, this study was carried out with the aim of analyzing the frequency and reasons for non-elective PICC removal in the PNICU of a PTRH of the state of São Paulo-Brazil and to identify the mean monthly cost of PICC consumption in the PNICU.

METHOD

This was a quantitative, exploratory-descriptive, retrospective study conducted at the PNICU after approval by the Research Ethics Committee of the PTRH (authorization no. 1370962).

The PTRH is a complementary body of a Public University, maintained by the State of São Paulo and linked to the State Department for Economic Development, Science and Technology. The financial

resources of the Hospital come from the University budget and the care provided to the Brazilian Nation Health System. Its PNICU has 13 active beds distributed in two distinct areas, one of which is for the Neonatal ICU with four beds, for the care of infants up to 28 days of age, and the other, with nine beds, for the Pediatric ICU, for the care of children from 29 days of age up to 14 years 11 months and 29 days.

The nursing team of the PNICU is composed of 1 head nurse, 14 clinical nurses and 28 nursing technicians. The daily number of personnel available during each work shift (morning, afternoon and night), is, on average, 2 nurses and 5 nursing technicians, distributed in the areas mentioned above according to the demand and the complexity of the care required by the NBs and children.

In the period from January to March 2017, all "PICC Monitoring" instruments resulting from successful PICC insertions for the year 2016 completed in the PNICU were analyzed. All instruments that were adequately completed and/or had few information gaps that could be retrieved from the nurses performing the PICC insertion were included.

The "PICC Monitoring" instrument in the PTRH of this study should be completed by the nurse soon after the PICC insertion has been finalized and should be complemented in the case of catheter related events. It has fields for the registration of the diagnostic hypotheses, age and sex of the patient (NB or child); to describe the reasons for indication, to distinguish the characteristics of the catheter (French caliber - Fr, number of lumens), the drugs used in the IVT, the aspect of the insertion site, the centimeters externalized, the occurrences and/or complications, the length time the device remains in place and whether the tip of the device was sent for culture.

The unit costs of the single epicutaneous catheters or kits (epicutaneous catheter and introducer) were obtained from the Purchasing and Warehousing Sector of the Hospital, the calculation of which was based on the mean of the prices paid in the last three acquisitions.

In order to perform the calculations, the costs originally provided in Brazilian Reais (R$) were converted into US$ at the rate of US$0.31/R$, based on the rate of 08/31/2016, provided by the Central Bank of Brazil. The collected data were stored in electronic spreadsheets and the variables presented by means of descriptive statistics in figures and tables.

RESULTS

The "PICC Monitoring" instruments relating to 101 PICC insertions in 73 (100%) patients admitted to the PNICU were analyzed, with 69.31% finalized with the successful insertion of the catheter.

Regarding the characterization of the patients, 33 (45.20%) came from the Children's Emergency Room, 13 (17.81%) from the Obstetric Center, 11 (15.07%) from Pediatrics, 8 (10.96%) from the Nursery and 3 (4.11%) from the Surgical Center; with 5 (6.85%) coming from other health services. There was a predominance of females (50.68%); 24 (32.88%) were hospitalized in the Neonatal ICU and 49 (67.12%) in the Pediatric ICU; 38 (52.05%) were receiving mechanical ventilation and 35 (47.95%) received other types of ventilatory support or were in ambient air. In the Neonatal ICU, 91.67% of the patients were newborns and in the PICU, 71.43% were infants. Of the 24 neonates submitted to PICC, 7 (29.20%) had gestational age between 24-28 weeks; 6 (25.00%) between 29-33 weeks; 2 (8.3%) between 34-36 weeks and 9 children (37.50%) had a gestational age greater than 36 weeks.

Frequent indications for PICC were prolonged IVT (64 patients), infusion of vesicant solutions, such as antibiotics and vasoactive drugs (64 patients), and infusion of hyperosmolar solutions (28 patients), with a single patient presenting more than one indication. Figure 1 shows the medical diagnostic hypotheses related to the indications. It should be noted that all patients had respiratory conditions and that there was a predominance of sepsis (47 patients) and prematurity (15 patients).

Figure 1 - Distribution of the medical diagnostic hypotheses of the PNICU patients submitted to the PICC insertion procedure, according to the grouping into categories. São Paulo, SP, Brazil, 2017

Grouping by category	Number of patients N (%)
Heart conditions	5 (6.85)
Renal conditions	1(1.37)
Respiratory conditions	73 (100)
Soft tissue conditions	9 (12.33)
Blood conditions	1 (1.37)
Central nervous system conditions	7 (9.59)
Gastrointestinal tract conditions	2 (2.74)
Prematurity	15 (20.55)
Sepsis	47 (64.38)

A total of 70 PICCs (100%) were inserted successfully, with 54.28% located in upper limbs. Regarding the length time remaining in place, 28 (40.00%) catheters remained 6-10 days, 21 (30.00%) 0-5 days and the remainder (21 - 30.00%) from 11 to >21 days. In Table 1, among the reasons for non-elective removal of 40 (100%) PICCs, the most frequent reports were infection/sepsis (22.50%), obstruction (20.00%) and rupture of the external portion of the catheter (20.00%).

Table 1 - Distribution of the reasons for non-elective removal of 40 PICCs inserted in patients admitted to the PNICU. São Paulo, SP, Brazil, 2017

Reasons	n	%
Infection/Sepsis	9	22.5
Obstruction	8	20.0
Partial rupture of the outer portion	8	20.0
Others*	7	17.5
Phlebitis	3	7.5
Extravasation	2	5.0
Infiltration	1	2.5
Death	1	2.5
Not reported	1	2.5
Total	40	100

*Others: suspicion of rupture, leakage at catheter insertion, contamination, reduction of artifacts in patients with two or more venous access routes, errors in the interpretation of the radiography in relation to the catheter positioning.

The tips of 26 (37.14%) catheters were sent for bacterial and/or fungal culture analysis. Of the 23 sent for bacterial analysis, there were 4 (17.39%) positive results, and of the 20 sent for fungal analysis there was 1 (5.00%) positive result. Two catheter tips were infected with *Staphylococcus epidermidis*, one tip had, in addition to this agent, *Pseudomonas aeruginosa* associated and another tip was infected with Staphylococcus haemolyticus; the fungus infected tip presented *Candida parapsilosis*.

Figure 2 shows the unit costs of the kits (epicutaneous catheters and introducers) and epicutaneous catheters, obtained from the mean of the previous three purchases made by the Purchasing and Warehousing Sector of the PTRH, converted to US$. The 2Fr/double lumen kit and the 1Fr kit represented the highest mean unit costs.

Figure 2 - Distribution of the mean unit costs, in Reais and US Dollars, of catheter kits and single catheters consumed in the PNICU. São Paulo, SP, Brazil, 2017

Items	Mean unit costs in R$	Mean unit costs in US$*
Kit-1Fr/single lumen	481.01	149.11
Kit-2Fr/double lumen	673.60	208.82
Kit-2Fr/single lumen	227.00	70.37
Kit-3Fr/single lumen	239.00	74.09
Kit-4FR/single lumen	239.00	74.09
Single epicutaneous catheter - 2Fr/3Fr/4Fr/single lumen	215.00	66.65

*Conversion rate: US$0.31/R$, based on the rate of 08/31/2016, provided by the Central Bank of Brazil.

In the study period, there were PICC insertion attempts that required the use of more than one kit or single epicutaneous catheter. Thus, total device consumption corresponded to 110 epicutaneous catheters, including 101 kits and 9 single catheters, totaling a direct cost of US$12,915.67 and a mean monthly direct cost of US$1,291.57. Regarding the material, 72 (65.50%) PICCs were silicone and 38 (34.50%) polyurethane and the majority single-lumen, 75 (68.18%).

As shown in Table 2, the greatest financial impact was related to the consumption of the 2Fr/double lumen kit, which presented the highest mean direct cost (US$208.82) and was the most consumed (35 units), followed by the 3Fr/single lumen kits (27 units) and 2Fr kits (29 units) where the consumption ranged from one to two kits per PICC insertion.

Table 2 - Distribution of the costs and quantities of catheter kits and single catheters used in 101 PICC insertion procedures. São Paulo, SP, Brazil, 2017

Material	Amount consumed	Mean cost US$*	SD US$*	Median US$*	Minimum-Maximum US$*	Minimum-Maximum consumed
Single catheter 2Fr-3Fr-4Fr	9	66.65	0	66.65	66.65	1-1
Kit - 1Fr	3	149.11	0	149.11	149.11	1-
Kit-2Fr/double lumen	35	208.82	0	208.82	208.82	1-1
Kit - 2Fr	29	72.88	13.06	70.37	70.37-140.74	1-2
Kit - 3Fr	27	80.02	20.10	74.09	74.09-148.18	1-2
Kit - 4Fr	7	74.09	0	74.09	74.09	1-1

*Conversion rate: US$0.31/R$, based on the rate of 08/31/2016, provided by the Central Bank of Brazil.

DISCUSSION

In the present study, the profile of patients undergoing PICC showed that, in the Neonatal ICU area the majority were of NBs, with gestational age over 36 weeks, and infants in the Pediatric ICU area. It should be emphasized that all neonates admitted to the Neonatal ICU remain in this area until the end of the hospitalization period, even if they pass 28 days of age and become infants.

Different results were found in a study performed in a Neonatal ICU of São Paulo, in which the mean age of the NBs was 34.1 weeks (SD - 4.09)[11] and in another study, conducted in an Neonatal and Pediatric ICU in Santa Catarina, which showed that 71.6% of the PICCs were used in infants up to 28 days, followed by the use of 24.34% of the devices in infants between 29 days and 11 months[12].

Annually, between March and August, an increase in the rate of hospital occupancy is expected resulting from respiratory diseases affecting the infant population in autumn and winter. All the PNICU patients presented some medical diagnostic hypothesis related to the respiratory condition. Sepsis, respiratory distress and prematurity were relevant medical diagnostic hypotheses, in line with what has been evidenced in the literature[2,4,12-14].

In one Neonatal ICU, it was verified that 86.5% of the neonates were diagnosed with prematurity[2]; in another Neonatal ICU, respiratory distress syndrome (19 - 36.2%), prematurity (13 - 22.4%) and neonatal anoxia (5 - 8.6%) was identified as the prevalent diagnoses[4]. A study that analyzed patients receiving critical care indicated the predominance of prematurity (60.8%); congenital heart disease/heart surgery (12.8%) and respiratory insufficiency/bronchiolitis/bronchopneumonia (10.4%)[12]. Another study investigated the prevalence of prematurity (82.6%) and respiratory discomfort (68.3%) in a private NICU[13]. In a university hospital, the neonates of the NICU presented diagnoses of prematurity (26.7%) and infant respiratory distress syndrome (26.7%)[14].

In the present study, a predominance of the PICC insertion site in the right and left upper limbs was found, contrasting with the results of another study[4], in which the majority of the insertions (31 – 52.0%) were located in the saphenous vein, followed by basilic vein (14 – 25.0%). Also, in the present study, the length of time the device remained in place was greater than 5 days (49 - 70.0%), corresponding to that expected for long-term access for IVT, however, this differed from that reported in a study[4], in which the length of time the device remained in place, in most of the cases of PICC use, was from 8 to 30 days.

One study[15] showed that the greater age of the child, the larger the PICC caliber, and the longer the length of time the device remained in place, with a mean of 49.9 days. Analysis of 484 medical charts of neonates using the PICC indicated the mean length of time the device remained in place of 12.9 days[13]. The use of 176 PICCs in 125 neonatal and pediatric intensive care patients of a private hospital showed a mean length of time the device remained in place of 14.5 days[16]. Another study in a Neonatal Intensive Care Unit found the duration of the PICC between 6 and 15 days[2]. It can therefore be concluded that the use of this device corresponded to that required for long-term access.

The most frequent reasons for non-elective PICC removal found in this study were similar to those observed in a study[17] performed in a neonatal ICU: infections related to venous access, obstruction, displacement and rupture of the catheter. In the study mentioned[17], transient metabolic disorders (hypoglycemia, calcium, magnesium, sodium or potassium disorders or dehydration), previous PICC insertions, use of a double lumen polyurethane catheters, PICCs with tip location in the non-central region and infusion of multiple intravenous solutions in single lumen catheters corresponded to the predictive factors of non-elective removal.

Furthermore, in the aforementioned study[17], the authors indicated that, with regards to the use of a double lumen catheter for the administration of a single solution, there was a fourfold increase in non-elective catheter removal compared to the single lumen catheter. With non-elective removal, in addition to causing the interruption of the IVT, additional, tangible and intangible, costs are generated, as well as stress and negative impacts on the health of the neonates, emphasizing the importance of avoiding repeated PICC insertions, positioning of the tip of the device in a non-central region and the use of a single lumen catheter for the infusion of four or more intravenous solutions[17].

The present study also identified that the majority of the catheters used (75 - 68.18%) were single lumen; however, the greatest financial impact was related to the mean cost of consumption of 35 2Fr/ double lumen kits (US$208.82).

At the McGill University Health Center, a lower rate of infections related to venous access and reinsertion of the device was identified when single lumen PICCs were used. When IVT with four different solutions was required, the single lumen catheter was more likely to undergo non-elective removal. In cases of patients with many comorbidities, the double lumen catheter was generally recommended and, because of these comorbidities, they were more exposed to complications that led to the non-elective removal of the PICC[18].

Therefore, in order to minimize costs, the institution established the type of catheter to be adopted, depending on the patient's profile, and two years later, a reduction in costs and in significant adverse

events was observed[18].

Thus, from the perspective of the results of this study, it is evident that the decision-making process, in relation to the type of catheter to be used, should be based on the patient's profile in order to contribute to the rational allocation of the material resources involved.

Among the reasons for non-elective removal of the PICC, in the PNICU of the present study, sepsis/infection was the most prominent (9 - 22.5%), revealing a rate higher than that found in a study[2] in which, among 186 PICC inserted , 123 (77.0%) had the tips sent for culture analysis. Of these, 13 (11.0%) resulted in positive cultures, with the predominant etiological agent being *Staphylococcus sp* (7 - 53.8%).

It was observed that the consumption of 110 epicutaneous catheters in kits (101) and single catheters (9), represented a high cost for the insertion of PICC in the PNICU, especially in relation to double lumen catheters. The financial impact of material resources on the provision of health services by nursing professionals has also been demonstrated in studies conducted by Brazilian nurses[19-23]. It is emphasized that the identification of costs related to the consumption of PICCs has the potential to support the sensitization of the professionals involved regarding the rational use of this product and the implementation, when and where possible, of opportunities to minimize costs.

For the adequate management of material resources, the involvement of the healthcare team is fundamental, since they are the main consumers and, because of their proximity to the care, they have the necessary conditions to verify the usefulness of the supplies and their benefits[24].

In the PTRH, the acquisition of material resources usually occurs through bids[25] and through previous approvals in the care units. In the period covered by this study, different types of PICC were tested, and the nurses of the PNICU gave technical feedback regarding their quality. The participation of nurses that perform this procedure in the process of acquisition of epicutaneous catheters, in partnership with the materials manager of the Nursing Department of the PTRH, made it possible to indicate those that best fulfilled the needs of the care practice, contributing to the efficacy and effectiveness of the results obtained, including economic aspects.

Nurses, who are responsible for coordinating the care team, unit or material management, need to gain knowledge regarding the worrying health costs considering the limited availability of resources[20]. From this perspective, the knowledge of the costs incurred in the procedures performed by nursing professionals has the potential to support the redefinition of priorities, increase the use of limited resources and favor the monitoring of productivity[24].

A limitation of the study is the fact that it was performed in only one hospital institution. However, because it is an initial approach on this subject, it contributes to the advancement in knowledge regarding the costs related to catheter consumption. Initial information may support future studies that show the costs of all materials used, as well as other aspects related to different types of venous access, favoring Benchmarking.

CONCLUSION

The performance of the present study in the PNICU of a PTRH provided the analysis of the reasons for non-elective removal of PICCs and the identification of the total direct cost and the mean direct cost of the consumption of this device. It is concluded that the clinical and financial knowledge obtained can help nurses in the decision-making process directed toward increasing the rational and effective use of the PICC in pediatric and neonatal critical and semi-critical units.

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