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Reasons for non-elective removal of epicutaneous catheters in neonates

CAUSAS DE REMOÇÃO NÃO ELETIVA DO CATETER EPICUTÂNEO EM NEONATOS

CAUSAS DE RETIRO NO ELECTIVO DEL CATÉTER EPICUTÁNEO EN NEONATOS

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ABSTRACT

This study aimed to describe the incidence and reasons for nonelective removal of epicutaneous catheters in neonates, identifying its association with the catheter insertion site. This was a prospective cohort study, conducted in a neonatal intensive care unit of a private tertiary hospital in the city of São Paulo, Brazil. We analyzed 266 epicutaneous catheter insertions. The incidence of non-elective removal was 39.1%. The most frequent post-insertion complications were suspicion of catheter-related bloodstream infection (25%) and rupture (23.1%). Most catheters were inserted through the right side of the body (65%), in upper limbs (77.1%), and using the axillary veins (31.2%). The findings did not suggest association between the incidence of non-elective removal and the insertion site of the epicutaneous catheter in neonates. Nurses should implement strategies to improve care and decrease incidence of non-elective epicutaneous catheter removals among neonates.

DESCRIPTORS

Infant, newborn
Catheterization central venous
Neonatal nursing

RESUMO

Objetivou-se descrever a incidência e as razões de remoção não eletiva do cateter epicutâneo em neonatos, verificando a associação com o sítio de inserção. Estudo de coorte prospectivo realizado em unidade de cuidado intensivo neonatal de um hospital privado terciário na cidade de São Paulo. Foram analisadas 266 inserções de cateter epicutâneo. A incidência de remoção não eletiva foi 39,1%. As complicações pós-inserção mais frequentes foram suspeita de infecção de corrente sanguínea relacionada ao cateter (25%) e ruptura (23,1%). A maioria dos cateteres foi inserida através do hemisfério corporal direito (65%), membros superiores (77,1%) e veias axilares (31,2%). Os resultados sugerem não haver associação entre a incidência de remoção não eletiva e o sítio de inserção do cateter epicutâneo em neonatos. Compete à Enfermagem implementar estratégias para a melhoria da prática assistencial a fim de diminuir a frequência de remoções não eletivas do cateter epicutâneo em neonatos.

DESCRITORES

Recém-nascido
Cateterismo venoso central
Enfermagem neonatal

RESUMEN

El objetivo fue describir la incidencia y las razones del retiro no electivo del catéter epicutáneo en neonatos, verificando la asociación con el sitio de inserción. Estudio de cohorte prospectiva conducido en una unidad de cuidados intensivos neonatales de un hospital privado terciario, en la ciudad de São Paulo, Brasil. Fueron analizados 266 inserciones de catéteres. La incidencia de retiro no electivo del catéter epicutáneo fue de 39,1%. Las complicaciones post-inserción más frecuentes fueron la sospecha de infección del torrente sanguíneo relacionada al catéter (25%) y ruptura (23,1%). La mayoría de los catéteres fueron insertados en el hemisferio corporal derecho (65%), en la extremidad superior (77,1%) y en la vena axilar (31,2%). Los resultados sugieren no haber asociación entre el sitio de inserción del catéter y la incidencia del retiro no electivo. Es de competencia de Enfermería implementar estrategias para mejorar la práctica asistencial con el fin de disminuir la frecuencia del retiro no electivo del catéter epicutáneo en neonatos.

DESCRIPTORES

Recién-nacido
Cateterismo venoso central
Enfermería neonatal

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INTRODUCTION

High-risk newborns usually require long-term intravenously (IV) infused drug treatments. The use of solutions with irritant and vesicant content to peripheral veins is common among IV therapies, such as electrolyte solutions, vasoactive drugs, antibiotics and parenteral nutrition. Central venous access devices have become vital to the recovery and survival of newborns admitted to neonatal intensive care units (NICU). In this context, the peripherally inserted central catheter (PICC) or epicutaneous catheter came to address the therapeutic demands of critically ill neonates[1].

Epicutaneous catheters offer a central venous access route through puncture of a peripheral vein from either the right or left side of body, in the cephalic-cervical region, or in upper or lower limbs. In the upper limbs, PICC can be inserted through the following veins: dorsal metacarpal, basilic, cephalic, median cubital, and axillary. In the lower limbs, the most commonly used veins are the great saphenous, the small saphenous and its derivations, the plantar venous arch, the medial marginal, the femoral and popliteal. The veins for central access in the cephalic-cervical region are the temporal, posterior auricular and the external jugular[2-3] veins. However, the most recommended veins for PICC insertions are in the antecubital fossa in the upper limbs. The basilic vein, due to its favorable anatomy, larger caliber and reduced number of valves is highly recommended, followed by the cephalic vein[3]. A study conducted with 45 newborns in a NICU identified the basilic as the vein selected among 22% of the PICC insertions, and the cephalic vein in 20% of the insertions[4].

...the association between body side, body segment and vein selected for peripherally inserted central catheter insertion and the occurrence of complications leading to non-elective removal has not relied on robust evidence to guide clinical practice of nurses...

The incidence of non-elective removal in PICC-lines may be related to the catheter insertion site. A study of 518 epicutaneous catheters in neonates compared the incidence of complications between catheters inserted in the femoral vein and in other sites. Its findings showed a significant increase in the catheter-related bloodstream infection rates when the femoral vein was used[5]. Regarding the body segment used at a PICC insertion, a survey with 396 infants with PICC demonstrated lower rates of catheter-related bloodstream infection among catheters inserted in the lower limbs when compared to those inserted in the upper extremities[1].

Given the above, the association between body side, body segment and vein selected for PICC insertion and the occurrence of complications leading to non-elective removal has not relied on robust evidence to guide clinical practice of nurses when it comes to the best site of insertion in NICU routine. Despite the relevance of the topic, especially for nurses responsible for the insertion and maintenance of PICC, studies on this topic are insufficient.

Considering the nurse's role in assessing the newborn venous system for PICC insertion, focusing on the prevention of post-insertion complications and, consequently, assuring patient safety, we realized the need to determine the incidence and reasons for non-elective removal of epicutaneous catheter in neonates, identifying its association with the insertion site.

METHOD

This was a cohort study with prospective data collection. The cohort consisted of neonates who underwent a PICC insertion procedure in a NICU of a large, private hospital in the city of São Paulo, from July 2010 to June 2011. The intensive care unit had 60 beds and the nursing staff consisted of 24 nurses and 124 nursing assistants and nursing technicians. Among all nurses, 22 were certified in the PICC insertion technique.

The monthly number of births in this institution was approximately 800, and approximately 30 PICCs per month were inserted in the neonatal unit. The procedures related to PICC insertion and management followed the institutional guidelines established by the hospital´ intravenous device study group.

The eligible newborns were those born in the hospital maternity, without diagnosis of congenital anomalies or coagulopathy, without loss of skin integrity caused by congenital diseases, and presenting data regarding the study variables recorded in the medical charts. The institution provided single-lumen silicone catheters of 1.9 *French* (Fr), and polyurethane dual-lumen catheters of 2.0 Fr.

After bedside PICC insertion using aseptic technique by trained nurses, both a neonatologist and nurse evaluated a chest radiograph to check PICC tip position, and its use was then allowed or not allowed. The insertion procedure and catheter maintenance care, as well as removal process, were recorded during every shift.

We considered the following variables for the study population characterization: sex, chronological age, weight, corrected gestational age, primary diagnosis, type of catheter used, tip position, and PICC indication (parenteral nutrition, antibiotics, general IV solution and/or vasoactive drugs).

The indication for catheter removal was considered as the main outcome in this study. Elective removal was considered when the removal occurred at the end of IV therapy. Non-elective removal was defined as those caused by PICC post-insertion complications, such as obstruction, rupture, catheter-related bloodstream infection, edema, accidental dislodgement, tip migration, infiltration or phlebitis.

Obstruction was considered as the impossibility to flush the catheter with a saline solution, using a 10 ml syringe, and no blood withdraw through the lumen. Catheter rupture was considered as the occurrence of a break in the external portion of the catheter. The presence of bacterial or fungal infection in patients with vascular device, and one or more positive result of peripheral blood culture, or clinical manifestations of infection (fever, chills or hypotension), with no other apparent focus of infection, was considered as suspected of catheter-related bloodstream infection.

Edema was defined as the identification of mild to severe swelling around the catheter insertion site or in the extremity of a catheterized body part during the permanence of the device. Accidental dislodgement is the inadvertent and accidental removal of the catheter, totally or partially. Migration is the displacement of the PICC tip, confirmed by radiography. Infiltration is the invasion of a non-vesicant solution or drug into the extravascular; extravasation is the invasion of a vesicant solution or drug into the extravascular. Phlebitis is a venous inflammation from a mechanical, chemical or bacterial cause[2-3].

The PICC insertion site was considered to be the independent variable. We considered the insertion site to be composed of: body side (right or left), body segment of venous access (upper limb, lower limb, cephalic-cervical region), and the selected vein (dorsal arch of the hand, dorsal arch of the foot, axillary, basilic, cephalic, median cubital, external jugular, popliteal, posterior auricular, saphenous and temporal).

The research project was approved by the Ethic Board of the institution under process number 219/10, following Resolution 196/96 of the National Health Council. Data were collected from medical records by using a specific instrument from the institutional PICC assessment form. Data were stored in a *Microsoft Office Excel 2007* spreadsheet and analyzed using *Stata 11.1*. Continuous variables were analyzed using descriptive statistics, and categorical variables using absolute and relative frequency. For categorical variables, the association between different insertion sites and the occurrence of non-elective removal was determined by the chi- square test or Fisher's exact test. The p-value for statistical significance was ≤ 0.05 with a 95% confidence interval.

RESULTS

The authors evaluated 309 PICC insertions in neonates regarding their eligibility criteria for inclusion in this study. After exclusion of unsuccessful insertions and those without enough data regarding the insertion site (selected vein, body side, segment of insertion), and reason for catheter removal, a total number of 266 events remained for analysis.

Among the study population, most infants were male (163 or 61.2%), appropriate for gestational age (221 or 83.4%) with a mean gestational age of 34.1 weeks, weight of 1,888.9 grams and postnatal age of 10.5 days. The most common clinical diagnosis was prematurity in 211 subjects (79.3%), respiratory distress in 171 (64.3%), twin pregnancy in 83 (31.2%), sepsis in 62 (23.3%), heart disease in 44 (16.5%) and disorders of the gastrointestinal tract in 35 (13.1%) subjects.

The single lumen silicone PICC was used in 187 (70.3%) insertions and the double lumen polyurethane 2.0 Fr catheter in the 79 (29.7%) remaining catheters. The epicutaneous catheter tip placement was central in most of the insertions (234 or 88.3%). The main indication for catheter insertion was the combination of parenteral nutrition and antibiotic therapy in 30% of the insertions, followed by electrolyte solutions and antibiotic therapy in 20% of catheter usages.

Regarding the PICC placement site, the right side of the body was the most used, in 173 of the insertions (65%). A total of 93 (35%) insertions were made in the left side of the body. The relative risk was 1.1 with a 95% confidence interval [0.81 to 1.52], therefore, the risk of non-elective removal of the PICC occurred independent of the body side selected. The most common body segment used was the upper limb, in 205 (77.1%) insertions, followed by the lower limbs in 35 (13.2%), and by the cephalic-cervical region in 26 (9.7%) events. The veins most frequently accessed for PICC insertion were the axillary veins in 83 (31.2%), followed by basilic in 49 (18.4%), cephalic in 37 (13.9%), and saphenous in 27 (10.1%). Elective removal was identified in 162 (60.9%) catheters, and non-elective removal in 104 (39.1%).

Table 1 – Association between the insertion site and indication for catheter removal – São Paulo, SP, 2011.

Variables	Nonelective removal N (%)	Elective removal N (%)	p-value
Body side			
Right	65 (62.5%)	108 (66.7%)	0.48
Left	39 (37.5%)	54 (33.3%)	
Body segment			
Upper extremities	78 (75%)	127 (78.4%)	0.72
Lower extremities	14 (13.5%)	21(13%)	
Cephalic-cervical	12 (11.5%)	14 (8.6%)	
Insertion Vein			
Axillary	41 (39.4%)	42(26%)	0.28
Basilic	17 (16.3%)	32 (19.7%)	
Cephalic	9 (8.6%)	28 (17.3%)	
Saphenous	12 (11.5%)	15 (9.6%)	
Median cubital	8 (7.7%)	16 (9.9%)	
External jugular	10 (9.6%)	9 (5.6%)	
Dorsal arch of the hand	3 (2.9%)	10 (6.2%)	
Dorsal arch of the foot	1 (1%)	3 (1.8%)	
Popliteal	1 (1%)	3 (1.8%)	
Posterior auricular	1 (1%)	3 (1.8%)	
Temporal	1 (1%)	1 (0.6%)	
Total	**104**	**162**	

No significant association was found between the PICC insertion site, i.e., body side, body segment and the vein accessed, and the non-elective removal of the catheter.

However, it was observed that among those epicutaneous catheters that were non-electively removed, the proportion of the axillary vein as the selected vein was higher: nearly 40% of the catheters. Among those electively removed, this proportion was only 26%. The opposite occurred in relation to the cephalic vein: among the electively removed catheters, this vein was used in approximately 17% of the insertions and among the non-electively removed, the cephalic was used in 8.6 % of the insertions.

The most frequent complications that led to the non-elective removal of the PICC were: suspicion of catheter-related bloodstream infection in 26 (25%) removals, rupture of the external PICC hub in 24 (23.1%), obstruction in 21 (20.2%), and accidental dislodgement in 14 (13.5%). Table 2 shows the association between complications resulting in non-elective removal and PICC insertion site.

There was no association between the site of PICC insertion and the different complications after insertion.

Table 2 – Association between the reasons for non-elective removal of the PICC and the catheter insertion site – São Paulo, SP, 2011.

Reasons for non-elective removal	Upper Extremities N (%)	Lower Extremities N (%)	Cephalic-cervical region N (%)	p-value
Suspected catheter-related bloodstream infection	21 (26.9%)	3 (21.4%)	2 (16.4%)	0.06
Rupture	17 (21.8%)	4 (28.6%)	3 (25%)	
Obstruction	19 (24.3%)	2 (14.3%)	0 (-)	
Accidental traction	10 (12.8%)	1 (7.1%)	3 (25%)	
Edema	5 (6.4%)	3 (21.4%)	1 (8.3%)	
Extravasation	4 (5.1%)	0	0	
Migration	1 (1.3%)	0 (-)	1 (8.3%)	
Infiltration	1 (1.3%)	0	1 (8.3%)	
Thrombosis	0	0	1 (8.3%)	
Decreased perfusion	0	1 (7.1%)	0	
Total	**78 (100%)**	**14 (100%)**	**12 (100%)**	**104**

DISCUSSION

Ensuring safe venous access in neonates is a constant challenge for nurses. However, only in recent decades, technological advances have enabled the development of safe central venous catheters, which are less traumatic and better tolerated in the venous system. Nonetheless, few studies have explored the influence of different insertion sites and non-elective PICC removal.

In this cohort, the neonates' clinical characteristics were similar to those found in a prospective study of 46 PICC insertions in 40 neonates in a NICU of Valdivia, Chile. The average of corrected gestational age was of 30.4 weeks, weight of 1,465 grams, and 37.5% of PICC indications was due to parenteral nutrition therapy[6].

The prevalence of respiratory distress syndrome was similar to a study in a tertiary public hospital in São Paulo that evaluated 37 neonates with PICC[7].

In the present study, although the chronological age average at the time of PICC insertion was of 10.5 days of life, 37.0% of catheters were inserted in neonates who were less than three days old. The results of a study conducted in a NICU indicated that those PICCs inserted before 5 days of life caused fewer complications (15.2%) when compared to catheters inserted later 5 days of life (24.4%)[8]. Factors such as edema, hypotension and dehydration can influence the catheter insertion procedure[9]. Immediately after birth, the neonate loses extracellular fluid, reducing the swelling, and consequently making PICC insertion easier.

Regarding the insertion sites identified in this study population, the right side of the body and the upper limbs were the most used. Studies showed a range of 42 to 82.4% of PICC insertions in the right side of the body[10-11]. There is similarity in veins of the upper limb on both right and left side from the hands through to the subclavian veins. From the brachiocephalic vein, the venous anatomy differs between the right and left side. The left brachiocephalic vein crosses the mediastinum to the right side in a direction toward the superior vena cava. The professional knowledge of the venous anatomy is essential for an accurate measurement of the catheter length[12].

Regarding veins, the majority of observations indicated the use of the axillary vein for PICC insertion. Other studies showed that the veins of the antecubital fossa were the first choice in 69.5% of attempts. We highlighted the use of the axillary vein in 28.2% of insertions, the basilic in 23.9%, the cephalic in 21.7%, and median cubital in 13%. The arches of the dorsal carpal veins were used in 8.7% of the insertions, and the jugular in 4.4%[6].

The choice of the axillary vein may be related to its larger diameter, which facilitates the puncture and progression of the catheter. Its size allows the use of catheters with larger caliber and a greater number of lumens. The main disadvantage of the axillary vein is the difficult visualization in older children caused by larger quantities of subcutaneous tissue. The proximity to the axillary artery increases the risk of arterial puncture.

The basilic was the second most used, followed by the cephalic vein. The basilic caliber is less tortuous than the cephalic, easy to puncture and presents an easy progression into the lumen, requiring less time to execute the procedure. It also allows safer fixation of catheter dressings and low incidence of phlebitis. The disadvantage is the anatomical proximity to the brachial artery, which increases the risk of accidental arterial puncture. When using the basilic, the PICC tip may migrate to the jugular vein, resulting in poor positioning of the catheter.

The cephalic vein has a smaller diameter than the basilic and has a smaller angle in it, gathering with the axillary vein, with one part of it going to meet the external jugular vein and the other remaining as the axillary vein. As the cephalic rises along the arm, it become narrow and tortuous, leading to an increased risk of mechanical phlebitis. It can also be more difficult to progress the catheter into the angle of the vein with the shoulder and induce a bad placement of the catheter tip in the axillary vein[3].

However, the veins of the lower limbs were also employed in 13.2% of the insertions, mainly the saphenous vein. The reasons for the election of the saphenous may be related to its high caliber and great length, the number of valves (ranging from 7 to 25 valves) and easy visualization next to the heel[3].

A retrospective cohort study conducted in a NICU in Beijing, that analyzed the risk factors for complications in 104 catheters inserted in newborns, found that the saphenous vein was elected in 11.5% of the insertions and that veins used for catheter insertion were not associated with nonelective removal (p=0.13). The findings on association between the selected vein and the incidence of non-elective removal are similar to this study's results[13].

A prospective, randomized study of post-insertions complications, comparing occurrences in proximal valve polyurethane PICC and distal valve silicone PICC, analyzed 392 catheters and their findings showed no association between complications and the vein used (p = 0.35) or body side (p = 0.24)[10].

In this study, the incidence of non-elective removal was similar to other studies conducted in different facilities, which ranged from 31.7%[13] to 47.7%[14]. However, the present study found that the main reasons for non-elective removal were different among the three possible segments of PICC insertion. Among the epicutaneous catheters inserted in the upper limbs, the most frequent complication was catheter-related bloodstream infection. It is an essential part of nursing care to prevent this complication, especially in neonates in whom the PICC was inserted in the upper limbs. Strategies to reduce catheter-related infections include nursing staff training on hand washing, protection of the catheter insertion site during newborn bathing, the use of gloves and antiseptic solutions while handling the catheter, the use of transparent and semi permeable dressings, and frequency of dressing change - weekly or whenever loss of adhesion or an unclean situation are observed, maximal contact precautions during catheter insertion, and use of catheters with the smallest number of lumen possible to meet newborn needs[15].

Among the catheters inserted through the lower limbs, the most frequent complication was rupture. The prevention of this complication includes staff training to flush the catheters using a 10 ml syringes in order to avoid excessive pressure[3]. Additionally, only trained nurses can perform maneuvers to clear the catheter by using a specific technique.

Finally, among the catheters inserted into the cervical region, the most frequent complications were accidental dislodgement and rupture. Avoiding newborns using their own hands to move the device should be done in order to prevent complications in the catheters inserted in this region. Furthermore, it is important to continuously evaluate the site of insertion and ensure the catheter stability and security while changing dressings[3].

Nurses are the main professionals responsible for the management and care of patients receiving IV therapy. Their performance includes a critical evaluation of the prescribed therapy, the choice of vascular device that meets the patient need, the installation procedure, the care for its maintenance and, finally, its removal. Moreover, their role is to design and implement practices that enhance patient safety and contribute to the improvement of patients' health status, especially in high-risk newborns.

As the PICC insertion site seems to have no association with the occurrence of complications, the nurse can choose to insert the catheter in the place that seems more visible, palpable and has healthier skin, according to their professional experience. Still, it is noteworthy that the use of technologies such as ultrasound can help the professional with the catheter insertion procedure, since it can facilitate the visualization and the puncture of deeper structures.

We highlight that one of the limitations of this study refers to the use of a single source for data collection, showing findings of a single institution, thus limiting generalizability of results to a broader population of neonates. The observational design may also be another limitation, since the data were obtained from medical records and data loss is common in this type of study. Despite the limitations, the findings deserve further exploration in subsequent studies, given the lack of studies that analyze the association between vein, body side and segment of PICC insertion, with the reasons for its removal, in neonates and in other populations.

CONCLUSION

The methodology used proved to be adequate for the study objectives. Its reproduction allows the development of further surveys in other neonatal units.

The findings brought elements for reflection and discussion of nursing practice regarding the choice of PICC insertion site in neonates. The most common complications were catheter-related bloodstream infection, rupture, obstruction and accidental dislodgment. Neither the PICC site of insertion nor the selected vein influenced the device removal. Findings suggest that nurses should implement actions to prevent the occurrence of complications related to epicutaneous catheters. In this context, nurses are accountable for implementing strategies and improving practice in order to decrease non-elective removal of PICCs in neonates.

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