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Use of peripherally inserted central catheter in a neonatal unit: a descriptive study

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ABSTRACT

Aim: analyze the use of peripherally inserted central catheter in terms of the aspects of technique, positioning and maintenance, as well as the influence on the number of venous dissections in hospitalized infants in a neonatal unit. **Method:** descriptive, retrospective, quantitative study, in reference maternity unit of a city in northeastern Brazil. Sample composed of 1,599 peripherally inserted central catheter insertions in 1,204 infants during the years 2006 to 2013. Instruments were used that recorded aspects of the insertion of peripherally inserted central catheter and venous dissection. **Results:** most babies were premature, of low birth weight and male. The veins of the cubital region were the most punctured with insertion success until the fourth puncture. The central positioning of the catheter tip predominated, with a permanency time between 11 and 20 days, removing it at the end of the treatment. Over the years, the number of venous dissections was inversely proportional to the insertion of peripherally inserted central catheter. **Conclusion:** this transvenous device was shown to be important for the treatment of hospitalized newborns, favoring reduction of venous dissections.

Descriptors: Infant, Newborn; Catheterization, Central Venous; Catheterization, Peripheral; Pediatric Nursing; Nursing Care; Phlebotomy.

INTRODUCTION

Technological innovation in terms of care, associated with the training of nursing professionals, has encouraged careful assistance, that is both humanized and effective with regard to the health of the newborn in neonatal units.

In this context, medical staff cater for premature newborns and of low birth weight - extremely vulnerable clientele which require minimal risk intravenous therapy for extended periods, aiming at the administration of antimicrobials, parenteral nutrition, vasoactive and irritants drugs⁽¹⁾. It therefore becomes essential that there is professional knowledge about the concentration of pharmaceuticals to be administered, the assessment of veins, the choice of suitable devices, skill in catheter insertion and maintenance with a view to a planned removal⁽²⁾.

As a central vascular access option for intravenous therapy in infants, there is the venous dissection. Currently it highlights the peripherally inserted central catheter, an innovative tool for safe care practice. It covers a number of advantages such as ease of insertion and handling, length of time that favors prolonged intravenous therapy, reducing multiple punctures, pain and risk of skin lesions. In addition, it is considered as the first choice to be excellent device inserted by peripheral venipuncture, centrally positioning⁽¹⁾.

Given the intention of improving the quality and safety of the baby nursing care, nurses should prioritize care about the insertion technique associated with the peripherally inserted central catheter, its maintenance, as well as the issues surrounding the choice of the vein, the expected results with the therapy and the relationship with other procedures such as venous dissection. We emphasize the relevance of the study facing the following questions: which veins are most commonly catheterized in the insertion of peripherally inserted central venous

catheter? How many punctures are necessary for insertion? What is the initial location of the catheter tip? What length of insertion is most common? What are the reasons for catheter removal? Does the insertion of a peripherally inserted central venous catheter influence the reduction or absence of venous dissection in babies?

This study aimed to analyze the use of peripherally inserted central catheter in the matters of the insertion technique, the positioning and maintenance of the catheter, as well as the influence on the number of venous dissections in the case of hospitalized infants in the neonatal unit.

METHOD

Descriptive, retrospective, quantitative research, in the neonatal unit of a public institution of reference, linked to the Rede Cegonha, in Fortaleza/CE.

The population consisted of all venous dissections and insertions of peripherally inserted central catheter during the study period. Thus, the sample consisted of 900 venous dissections and 1,599 insertions of peripherally inserted central catheter, held in 1,204 infants between January 1st, 2006 and December 31st, 2013. It is noted that the venous dissection data comes from records from 2006 when the catheter was acquired in the studied institution, and in 2007, when this device was first used. It is found that the number of infants differs from the number of insertions because some have undergone more than one insertion due to therapeutic needs.

Data collection consisted of identifying the records in three tools used routinely by the institution in following up the infants who perform such procedures between January and March 2014. The recorded variables focused on date

of birth, gestational age at birth, chronological age, weight at birth and at day of insertion, gender, Apgar in the first and fifth minutes of life, medical diagnosis at birth, indication and required number of venipunctures for insertion, the catheterized vein, the catheter tip location, withdrawal reason and length of stay.

The procedure is performed by nurses trained by qualification course in peripherally inserted central catheter insertion. This indication occurs with hyperosmolar venous infusion prescriptions such as parenteral nutrition and/or antimicrobial and/or vasoactive drugs, lasting more than six days. The right cubital region is preferable for insertion into the basilica vein, with the baby in a heated incubator, using a maximal sterile barrier technique and a polyurethane neonatal 1.9 french catheter with detachable introducer. The pressure dressing is made with gauze and a sterile semipermeable membrane and replaced with 24 hours of insertion. Then a chest radiograph is performed for catheter tip visualization. As for removal, the reasons are many and inherent to the end of treatment, by not central location or occurrence of complications. As the decision between doctor and nurse, the removal is made by the nurse, using a sterile technique, performing skin antisepsis with chlorhexidine topical, in a firm, slow motion, centimeter by centimeter, comparing the final size of the catheter with the initial and medical records. In order to prevent clogging of the catheter used to infuse only antimicrobial, infusion of saline 0.9% at a speed of half a milliliter per hour is used, and a flushing saline solution 0.9%, twice the catheter priming volume is used before and after each drug infusion.

To organize and analyze the data, we used Microsoft Office Excel 2007 software, with an emphasis on descriptive statistics with absolute and relative frequency, dispersion and central measures such as median and standard deviation.

The study was submitted to the Ethics Research Committee of the institution in which the study took place, and was approved in 2009, under protocol n° 179/09, given the ethical principles established by Resolution N° 196 on research on human beings⁽³⁾.

RESULTS

With regard to peripherally inserted catheter insertion practice, it is considered appropriate to have knowledge of the birth variables that characterize the infants. In this study, males predominated (641; 53.2%), appropriate weight for gestational age (214; 17.8%), low birth weight, between 1,500 and 2,499g (750; 62.3%), and extremely low birth weight (216; 17.9%). In the diagnostic evaluation, 1,105 (91.8%) infants were identified with early respiratory distress and 989 (82.1%) were preterm infants, highlighting 253 (21.0%) at 29 weeks or less; 736 (61.1%) of 30 or less than 35 weeks.

Regarding the age of the babies on the day of catheter insertion, 826 (51.7%) were less than seven days old; 363 (22.7%) were between eight and 14 days old; 91 (5.7%) were between 15 and 21 days old; 72 (4.5%) were between 21 and 28 days old; 211 (13.2%) were more than 28 days old and 36 (2.2%) files had no record. As for the weight, 320 (20.0%) infants were found to be less than 1,000 g; 505 (31.6%) were between 1,000 and 1,499g; 521 (32.6%) were between 1,500 and 2,499g; 210 (13.1%) were more than 2,500 g, and 43 (2.7%) had no information in the medical records.

The results of the study that include aspects of insertion, maintenance and removal of peripherally inserted central catheter are shown in Tables 1 and 2, and the comparative venous dissections versus peripherally inserted central catheter are shown in Figure 1.

Table 1 - Distribution peripherally inserted central catheter according insertion indication, number of punctures, catheterized vein and initial positioning of the tip. Fortaleza, 2014. N = 1599.

Indication	N	%
Antimicrobial	1.446,00	90,40
Parenteral nutrition	706,00	44,20
Vasoactive drugs	26,00	1,60
Number of punctures		
1-2	673,00	42,10
3-4	275,00	17,20
5-6	144,00	9,00
≥7	164,00	10,30
Not informed	343,00	21,40
Catheterized vein		
Basilica	430,00	26,90
Cephalic	363,00	22,70
Axillary	238,00	14,90
Temporal	123,00	7,70
External jugular	98,00	6,10
Retroauricular	48,00	3,00
Median cubital	36,00	2,20
saphenous	6,00	0,40
Other/ Not informed	257,00	16,10
Initial positioning of the tip		
Central	983,00	61,50
No Central	205,00	12,80
Not visible / Not specified	411,00	25,70

Source: own elaboration

As can be seen in the table, the catheter insertion indication refers to antimicrobial infusion, parenteral nutrition and vasoactive drugs, noting that in some cases there were indications of simultaneous infusion.

Regarding the number of venipuncture attempts required prior to insertion, highlighted that successful insertions up to second attempt occurs more often and, less commonly, five to six attempts.

Regarding the veins of first choice for catheterization, the basilica, the cephalic and median cubital, were chosen for more than half of the insertions, followed by the saphenous and posterior auricular vein.

Most of the insertions (983; 61.5%) presented the catheter tip in the central positioning.

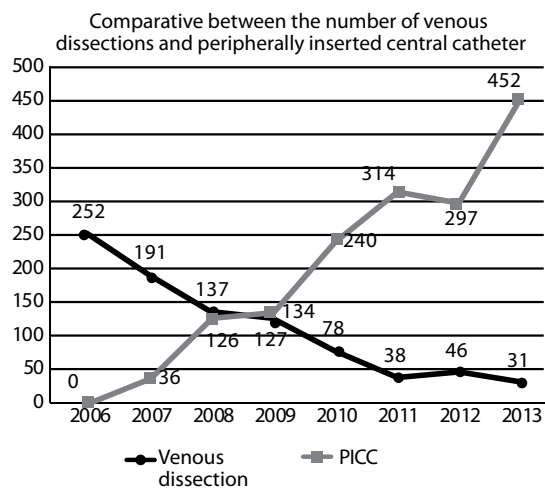
Table 2 - Distribution of peripherally inserted central catheter regarding length of permanence and reason for removal. Fortaleza, 2014.

Length of permanence (days) (N=1599)	N	%
0-7	550	34,4
8-14	529	33,1
15-21	245	15,3
22-28	137	8,6
>28	118	7,4
No data	20	1,2
Reason for removal (N=1548)*		
End of treatment	795	51,4
Rupture	115	7,4
Obstruction	107	6,9
Spontaneous output	93	6
Signs of inflammation associated with central location	75	4,8
Removed before treatment completion	73	4,7
Death	72	4,7
Positive blood culture for fungus and/or clinical signs of fungal infection	67	4,3
Signs of inflammation associated with non-central location	56	3,6
Peripheral	38	2,5
Signs of inflammation without tip location	20	1,3
Other/No information	37	2,4

* The number of reasons to remove differs from inserts due to the transfer of 51 babies with peripherally inserted central catheter to another hospital.

Most babies had a catheter in place for at least seven days; 118 (7.4%) of them for more than 28 days, with an average length of 12.70 ± 9.87. Several reasons for catheter removal were identified, especially completion of treatment, rupture and obstruction. However, it is emphasized that signs of inflammation (redness, infiltration, heat, pain) also led to the removal of 75 (4.8%) catheters in central positioning; 56 (3.6%) with no central positioning and 67 (4.3%) had positive blood culture results and/or clinical signs of systemic fungal infection, considering the risk of the catheter being a source of infection to the baby.

Figure 1 - Comparative between the number of venous dissections and peripherally inserted central catheter of 2006 to 2013. Fortaleza, 2014.



As can be seen from the graph, there are a significant number of peripherally inserted central catheter insertions compared to the number of venous dissections, indicating a significant decline every year.

DISCUSSION

For optimum nursing performance, it is necessary to develop skills and expertise that enable nursing staff to meet the specific needs of infants in the use of peripherally inserted catheters for intravenous therapy. Such patients are considered vulnerable because they are exposed to a greater possibility of the occurrence of adverse events during hospitalization.

In this study, there was a significant number of insertions of peripherally inserted central catheter during the studied period, which favored the reduction of multiple punctures, as well as contributed to the nursing care in terms of infusional therapy.

Highlighting the characteristics of the babies studied, males predominated, as did low birth weight and preterm infants with

the syndromes of respiratory distress or with a hyaline membrane disease diagnosis. These characteristics indicate similarities with the study that investigated the association between intravenous therapy and the non-elective removal of 97 central catheter peripherally inserted in neonates who showed an average weight of less than 2,000g, male (59; 60.8%), prematurity (87; 89.7%), respiratory distress (70; 70.2%), heart disease (16; 16.5%), sepsis (15; 15.5%), gastrointestinal disorders (9; 9.7 %) and electrolyte disturbance (5, 5.2%)⁽⁴⁾.

The study shows that the indications of insertion are related to the infusion for parenteral nutrition and antibiotics for prolonged time, demonstrating appropriate indication for the baby's protection and comfort. In addition, this device helps reduce painful intravenous procedures in very low birth weight babies, without additional morbidity⁽²⁾.

Regarding the number of venipunctures in order to insert the catheter, over half occur until fourth attempt, prevailing from one to two punctures (673; 42.1%). It is known that the minimum of attempts in the punctures demonstrates greater success and quality of the procedure⁽⁵⁾.

A recent study characterized the use of peripherally inserted central catheters in neonates and found that 32 insertions (46.37%) were considered successful in both the first (18.84%) and second attempt⁽⁶⁾, which differed from the results with regard to first puncture insertion in this study. A prospective study of 63 infants with weight below 1,251g, with insertion of peripheral venous and peripherally inserted central catheter, found that the number of catheters and attempts was significantly lower in the group of peripherally inserted central venous catheter than in those involving peripheral access (p-value=0.008 and 0.002 respectively)⁽⁷⁾.

In order to check predisposing factors for the failure of peripheral intravenous puncturing

in children, an investigation showed a failure rate of 10.4% in terms of punctures, showing hematoma, capillary fragility, decreased skin turgor, previous use of central venous catheters, malnutrition and body fat in infants as associated factors. Such knowledge is evidence for professional practice for the patient safety and better outcomes⁽⁸⁾

Diligence in venipuncture procedures reduces the stress and pain due to multiple punctures, improving the quality of the baby nursing care, but emphasizes the importance of in-service training and careful evaluation of the veins. Preservation of the catheter insertion site, professional ability with regard to venipuncturing, and elective indication of insertion as first choice, before the depletion of peripheral veins for multiple venous and arterial punctures, are aspects that favor such success⁽²⁾

About punctured veins and insertion sites, the data revealed the veins accessed in the cubital region (basilica, cephalic and median) as being the most frequently catheterized. There's recommendation to use primarily the cubital region for catheter implantation, except those of the right arm of babies undergoing repair of heart defects, in order to predispose to decreased blood flow in the subclavian artery; apart from these cases, antecubital veins offer less path, less valves and risk of accidents in the puncture, besides being of a larger caliber⁽¹⁾

A survey conducted in southern Brazil involving the insertion of peripherally inserted central catheter in a neonatal unit identified the veins of the cubital region as the most commonly punctured (cephalic, 27.53%; median basilica, 24.63%; basilica, 13.04%), resembling the results of this article⁽⁶⁾. Another study conducted in Italy also points out the antecubital region as the most suitable for insertion of peripherally inserted central catheter, as well as peripheral venous catheter by having less association with

phlebitis⁽⁹⁾

It is emphasized that the search for different insertion sites of the cubital fossa has the potential causes not to preserve the region for insertion of the catheter as the first choice. This may be associated with previous punctures of the artery in the cubital region, forming bruises and favoring the catheter bad progress. In this study, 311 insertions were also registered (19.4%) in axillary, temporal, posterior auricular, external jugular and lower limbs veins.

Due to the difficulties of performing puncture in infants, nurses seek alternatives superficial venous network. As Table 1 indicates, 98 insertions (6.13%) were performed in the external jugular vein, demonstrating the competence and the practical skills of nurses with regard to venipuncture. It warns, however, the need for training, skill and careful technical evaluation. A retrospective, descriptive study, developed in neonatal intensive care units in Paraná, found 10.4% of catheterisation in the external jugular vein, with insertion of a peripheral central catheter⁽⁶⁾.

The use of multiple sites for the insertion of peripherally inserted central catheter is not only practical in the institution in which this study was carried out. In São Paulo, researchers investigated the non-elective removal of the epicutaneous catheter and it was found that 79 (81.4%) were inserted in the veins of the arms, 13 (13.4%) in leg veins, and five (5.1%) in the cervical area or scalp⁽⁴⁾.

A survey conducted in Turkey, with retrospective data analysis of the insertion of peripherally inserted central catheter between 2004 and 2010, through venous cannula as the introducer and scalpel, showed 95% of insertion success in saphenous vein; 86% in first puncture and length of stay of 7.7 ± 5.6 days⁽¹⁰⁾.

It is expected that the positioning of the tip of the peripheral central catheter after insertion

is in the superior vena cava⁽¹⁾. This is identified by chest radiography, two vertebrae below the carina^(11,12). The carina is considered to be an anatomical reference landmark of the superior vena cava for the location measurement of the peripherally inserted central catheter tip in infants, due to the superior vena cava not being a visible structure on chest X-rays. In the present study, it was found that most catheters respected scientific recommendation.

It is recommended to measure the distance between the insertion point and the superior vena cava to the correct location of the catheter tip. Proper placement of the catheter in central vasculature enables the use uneventfully. This approach avoids a bad location, in that it measures the distance to be traveled by the catheter into the blood stream, avoiding anterior or posterior positioning to the superior vena cava, or even in peripheral venous branches, leading to the need for further traction or removal⁽¹⁾.

Research conducted with children in order to define the formula for calculating the distance, based on age, gender, weight, size and body surface area, concluded that the predictive linear equation to determine the proper size for central venous catheter insertion depends only on the body surface area and a constant⁽¹³⁾.

When checking the average of length of stay in this study it was found to be 12.7 ± 9.9 days, with minimum and maximum time of one and 83 days, respectively. These data are similar to search results developed in a university hospital in Curitiba (PR), which showed the average length of stay as being 14.82 ± 15.06 , with a minimum time of zero and a maximum of 78 days⁽¹²⁾.

It is noteworthy that most babies had the catheter implantation before the seventh day of life. This is considered a safe and effective option for the management of venous infusions, for more than 6 days⁽⁵⁾. It is emphasized in the prac-

tice of the institution studied, that the elective removal of the umbilical catheter occurs on the seventh day of use. However, when it is necessary, it may be removed before this period due to poor location, hyperemia of the umbilical stump, infiltration, or accidental output. And with the removal, it is indicated the use of percutaneous.

It is recommended that the length of stay of the peripherally inserted central catheter is sufficient to comply with intravenous therapy. In the study institution, the catheter remains even though the osmolality of parenteral nutrition has been reduced to levels compatible with infusion into a peripheral vein. This practice is due to the extreme fragility of the venous network of the assisted population, with most baby being of low birth weight and preterm. The high permanence average suggests that the maintenance of the catheter is satisfactory, but may also indicate that the baby is not improving in terms of its clinical status, having to continue with infusional therapy.

During the baby's intravenous therapy, the longer the catheter maintenance time, the less need for venopuncture, reducing the entry sites for infection⁽⁵⁾. However, it requires appropriate nursing care to promote the maintenance of the catheter until the end of the therapy. It was observed that more than half of the catheters were removed at the end of treatment and, in a lower proportion, due to obstruction, breakage and the presence of signs of inflammation. We have found similar results in a study that showed all removals by the end of treatment⁽¹⁰⁾.

A study of complications involving central catheter peripherally inserted in Curitiba showed only 22.2% of elective removal, with 77.8% non-elective, due to such factors as spontaneous output, extravasation, edema, fractures, hyperemia, obstruction, death and positive blood culture⁽¹⁴⁾, and neonatal intensive care unit of a private hospital in São Paulo, it was

found that removal was due to rupture (23.3%), the catheter being associated with infection (26.7%) and obstruction (26.7%)⁽⁴⁾

The non-elective removal of the catheter due to blocking, for example, predisposes to practice multiple catheterization of infants for need of return or continuity of infusional therapy; and the replacement of the device due to catheter colonization by fungus aiming to full clinical recovery.

About obstruction - a major mechanical cause of removal of peripherally inserted central catheter in babies – a retrospective study of case-control analyzed 33 patients with 47 catheters, compared two groups, one with and one without the continuous infusion of heparin. The average stay was 24 and 16 days respectively, with no significant statistical association (p -value = 0.07) (15). This practice, although described in the literature, is not part of the routine of the institution studied, where it was detected that 6.9% of removal was due to obstruction.

A study with 341 patients, using 126 catheters and 709 lumens, to compare the effect of saline solution 0.9% and a solution of heparin in the prevention of catheter obstruction, verified that both are similar and before the risk of the heparin induce thrombocytopenia, suggested the use of saline 0.9% flushing to prevent catheter obstruction⁽¹⁶⁾.

For the unblocking of central catheters in clinical practice, nurses empirically have used vitamin C infusion. An experimental study *in vitro* showed that vitamin C has an effect in preventing clot formation, but with less intensity in the two days after the formation of the clot, not giving, however, the effect in breaking the clot in clogged catheters, being recommended by researchers and being established in the pediatric department of the National Cancer Institute⁽¹⁷⁾. However, this practice is not adopted in

the institution where the study was developed. Instead, medical staff used continuous infusion and flushing of saline solution.

The importance of the removal of a peripherally inserted central catheter immediately after completion of the infusions, in a study about “bundle”, was associated with patient safety, in terms of the prevention and reduction of bloodstream infection associated with catheter. As methods for the prevention of infection the following are emphasized: hand hygiene; alcoholic chlorhexidine for skin antisepsis; the use of maximum barrier precaution; non-femoral vein catheterization; and a daily check of the need for the catheter, with immediate removal when not indicated⁽¹⁸⁾

Research in North Carolina (USA), has shown that for the reduction of blood infection associated with central catheter use in neonates, engagement of the multidisciplinary team in the Neonatal Intensive Care Unit, active partnership with the family, and efforts to improve the quality of care are required. The results showed a reduction of 71% in the infection rate, while the goal was to achieve a reduction of 75%⁽¹⁹⁾. An integrative review highlights gaps in the research for the prevention of bloodstream infection associated with catheter use in newborns, and highlights the importance of nursing staff who are responsible for the installation and maintenance of this device⁽¹⁸⁾.

In Turkey, research showed association between the risk of infection development and increased daily load of nursing work because of a lack of staff in a neonatal intensive care unit. Considers that the nosocomial infection weighs on spending on health and to control nosocomial infection in intensive care units, the nursing workload, staff dimensioning and working conditions must be adequate⁽²⁰⁾

The involvement of nurses in intravenous therapy promotes good practice, with periphe-

rally inserted central catheter, production and dissemination of knowledge with a view to the humanization of care and healthy development of the baby, which in this study, it appears by the progressive amount of insertions of peripherally inserted central catheter and the reduction of venous dissection, the low number of punctures prior to insertion, the care and maintenance up to removal, reducing manipulation, pain and stress for the baby, promoting patient safety and humanization of care.

Venous dissection in the internal jugular vein in infants is preferred by pediatric surgeons, and studies have shown higher rates of infection related to catheter insertion by venous dissection than by peripheral puncture, due to higher density of microorganisms on the skin of the neck than on the upper limbs⁽⁵⁾.

A study examining the adverse effects of central venous access has shown that babies who received venous dissections have had a lower average length of stay (10 days) than the peripherally inserted central catheter (12 days). However, the data showed higher infection rates for venous dissections (26.3%) than for peripherally inserted central catheter (18.6%). In the practice of intravenous therapy there is a need for the standardization of care practices for newborns in order to minimize the mechanical and infectious complications associated with the use of central venous catheters⁽²¹⁾.

A study in order to evaluate the vascular access management in very low birth weight babies found mechanical complications, phlebitis and neonatal sepsis in 25% of the causes of venous dissection removal and 50% for death⁽²²⁾.

Research on complications related to the use of epicutaneous catheters in infants shows that non-elective removal is not associated with preventable complications such as obstruction, external disruption, suspected infection and ac-

cidental traction due to the adoption of preventive measures such as monitoring the dressing adhesion loss, with a change every 7 days and the use of sterile gloves, hand hygiene, use of 10 mL gauge needle, monitoring the increased resistance to infusion, disinfecting connections, through three times friction of gauze soaked in alcohol 70%⁽²³⁾. This time, it is recommended that the use of venous dissection be done with caution, and only if there are no other options in terms of the insertion site⁽¹⁾.

Regarding to patient safety in infusional therapy, the research emphasizes the importance of the systematization of nursing care for babies with peripherally inserted central catheter, about the insertion, maintenance and removal of the catheter. This is fundamental for the process of registration, highlighting the need for the participation of the team in intravenous therapy team training⁽²⁾. Therefore, continuous education is still the best way to provide the catheter removal by discharge from treatment and to prevent complications that compromise the quality of intravenous therapy⁽²¹⁾.

CONCLUSION

Most babies born prematurely, underweight, and implied the indication of parenteral nutrition and antibiotics through peripherally inserted central catheters. Regarding the choice of the veins to be used for insertion the cubital vein predominated with one or two attempts at successful insertion, highlighting the initial positioning in the central vasculature and removed after treatment. With the insertion of peripherally inserted central catheter in the routine practice of neonatal unit investigated, they reduced the number of venous dissections.

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