

Knowledge and Care related to Peripherally Inserted Central Catheter (PICC) in Pediatrics and Neonatology Nursing: an Integrative Review

Michelle Darezzi Rodrigues Nunes¹, Gabriela Rodrigues Ferreira², Fernanda Machado Silva-Rodrigues³, Benedita Maria Rêgo Deusdará Rodrigues⁴, Sandra Teixeira de Araújo Pacheco⁵ & Lucila Castanheira Nascimento⁶

Abstract

Peripherally Inserted Central Catheters (PICC) have been used for decades in diverse settings. The aim of this study was to review the literature regarding the knowledge and care related to PICC lines in Pediatrics and Neonatology. An integrative literature search of studies published between 2005 and 2015 was conducted in Pubmed, Web of Science, CINAHL, LILACS, and SciELO using the terms in different combinations: newborn, child, neonatal intensive care, pediatric intensive care, peripherally inserted central catheter, PICC, and nursing. Ten studies were reviewed, most of them conducted by Brazilian nurses. The results were summarized in two thematic categories: (1) Nursing care using PICC lines, and (2) Nursing clinical practice related to the use of PICC lines. Few studies reported the care and practices of using PICC in neonatology and pediatric settings in the last ten years. The use of new technologies has contributed significantly to the increasing number of PICC insertions with decreased patients' risks. The results of this study also highlighted the limitations of nursing knowledge about PICC line care. Therefore, updated activities and knowledge acquisition are essential for nurses in order to establish guidelines for the use of this device in Neonatology and Pediatrics

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¹RN, PhD, Assistant Professor, School of Nursing at Rio de Janeiro State University, Department of Maternal-Infant Nursing. Address: Boulevard 28 de Setembro, 157, Vila Isabel, 20551-030, Rio de Janeiro, RJ, Brazil, Phone: +55 (21) 2868-8236. E-mail: mid13@hotmail.com (Corresponding author)

²RN, Specialist in Newborn and Pediatric Intensive Nursing Care. Email: gahenf31@gmail.com

³ RN, PhD Candidate, University of Sao Paulo at Ribeirão Preto College of Nursing, WHO Collaborating Centre for Nursing Research Development, Ribeirão Preto, SP, Brazil. Instructorat Santa Casa de Sao Paulo School of Medical Sciences, São Paulo, SP, Brazil. Email: fermachado@usp.br

⁴RN, PhD, Full Professor School of Nursing at Rio de Janeiro State University, Department of Maternal-Infant Nursing. Rio de Janeiro, RJ, Brazil Email: benedeusdara@gmail.com

⁵ RN, PhD, Assistant Professor, School of Nursing at Rio de Janeiro State University, Department of Maternal-Infant Nursing. Rio de Janeiro, RJ, Brazil. Email: stapacheco@yahoo.com.br

⁶RN, PhD, Associate Professor, University of Sao Paulo at Ribeirão Preto College of Nursing, WHO Collaborating Centre for Nursing Research Development, Ribeirão Preto, SP, Brazil. Email: lucila@eerp.usp.br

Introduction

Despite being initially described in 1929, Peripherally Inserted Central Venous Catheters (PICC) began to be used in hospitalized patients only in the 1970's as the result of its benefits and simple insertion, which is usually followed by less mechanical occlusions, phlebitis, or infection complications. The use of PICC lines was encouraged through training programs for nurses. In Brazil, the device was introduced in neonatology, pediatrics, intensive care, oncology, and homecare in 1990 (Oliveira et al., 2014).

PICC lines are central vascular devices, with a single or double lumen, made from materials (silicone and polyurethane) that are compatible with the human body and present low thrombogenicity; they are inserted into a peripheral vein and positioned in the superior or inferior vena cava. Its use is recommended in the administration of hyperosmolar, irritant, or vesicant medications (Oliveira et al., 2014).

The normative resolution n. 258/2001 from the *Brazilian Federal Council of Nursing* (COFEN) sets out some principles for the insertion and maintenance of PICC lines regarding professional qualification and habilitation to insert and manipulate this device (Baggio, Bazzi & Bilibio, 2010). COFEN grants legal clearance for trained professionals to perform PICC. Nevertheless, nurses need technical and theoretical knowledge based on scientific evidence to make clinical decisions and promote satisfactory results during the insertion and maintenance of PICC lines.

The advantages of using PICC are related to its safety (insertion), its non-surgical procedure, local use of anesthesia, it is inexpensive compared to other central venous devices, presents a low risk of causing drugs' infiltration or chemical phlebitis, and allows the administration of high pH, vesicant, and hyperosmolar solutions. Moreover, only certified nurse's can perform the insertion procedure (Vendramim, Mavilde & Peterlini, 2007).

Nurses enrolled in the care of children and newborns under intravenous therapy need abilities and specific knowledge regarding the anatomic and physiological characteristics and the growth and developmental stage of these patients. These nurses also need to be involved in the development of guidelines that will lead a practice based on the use of scientific evidence to ensure safety while using intravenous devices (OLIVEIRA et al., 2014). Evidence-based practice improves the quality of care and decision-making initiatives because it involves the definition of a problem, search and critical evaluation of available evidence, implementation of protocols, and evaluation of results. Considering all these aspects, this study analyzed the national and international scientific literature about the knowledge and care related to PICC lines in hospitalized newborns and children.

Methods

This study was an integrative review of the literature consisting of a broad review by collecting, evaluating, and synthesizing publications in order to contribute to the understanding of a particular problem by providing evidence-based practice subsidies through informed knowledge (Whittemore & Knafl, 2005).

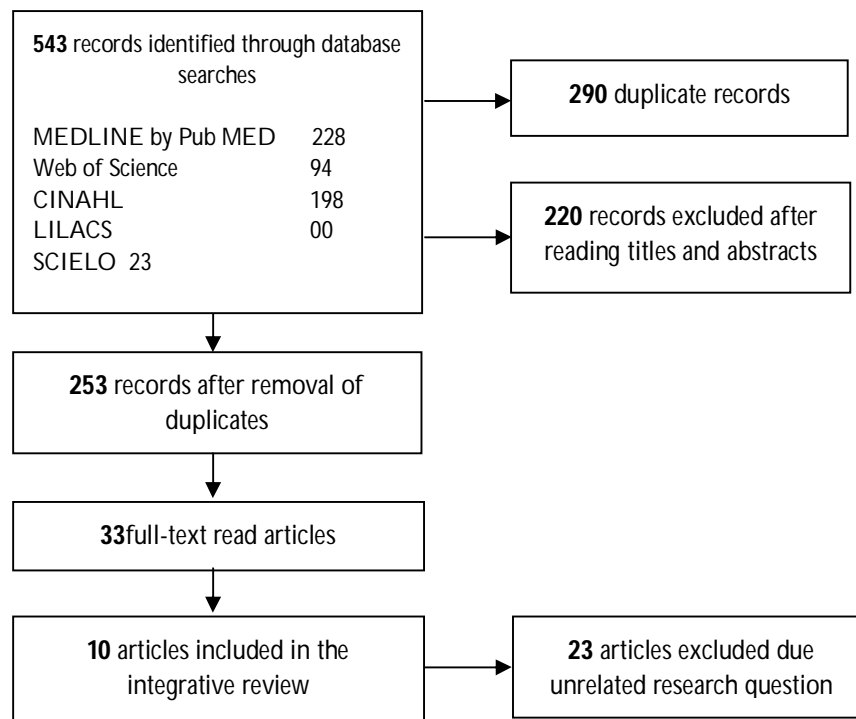
The study used the following stages: 1. Problem formulation (elaboration of the research question, keywords, and inclusion criteria); 2. Search procedures (inclusion of relevant literature on the topic of interest); 3. Data evaluation (extraction of relevant information from selected articles); 4. Data analysis and interpretation (data integration process); and 5. Review presentation (synthesis to illustrate the process of data integration) (Mendes, Silveira, Galvão, 2008). The defined research question was: "What are the knowledge and nursing care regarding the use of PICC in pediatrics?" The following databases and electronic libraries were searched: CINAHL (Cumulative Index to Nursing and Allied Health Literature), Web of Science, MEDLINE via Pubmed (National Library of Medicine [USA]), LILACS (Latin American and Caribbean Literature in Health Sciences), and SciELO (Scientific Electronic Library Online). The following DeCS (Descriptors in Health Sciences), MeSH terms (Medical Subject Headings), and keywords were entered into the databases in different combinations: "Child", "Infant", "Newborn", "Neonatal Intensive Care", "Pediatric intensive care", "Nursing", "Peripheral Catheterization", "PICC", and "Peripherally Inserted Central Venous Catheter".

The inclusion criteria were: a) original articles, b) written in English or Portuguese, and c) published by nurses or nurses working as research members of multi-professional teams between January of 2005 and December of 2015. The exclusion criteria were: 1) dissertations and thesis, and non-research articles such as reviews and opinion papers, or 2) not conducted with newborns, children, or adolescents. 543 papers were identified; the authors to ensure rigor in the selection of those contemplating the guiding question and meeting the inclusion and exclusion criteria read titles and abstracts independently. 33 studies were selected for full-text reading.

Study Selection

Out of the 33 full-text read articles, 23 were excluded because they used peripheral catheters ($n = 5$), studied adult populations ($n = 7$), were not published in Portuguese or English ($n=2$), and did not focus on research-related themes ($n = 9$). The final sample for the review consisted of 10 studies (Figure 1).

Figure 1: Flow chart of the process of study selection.



The authors elaborated an instrument for the extraction of data by evaluating the selected articles according to the following variables: country of origin; authors' professional field of work; year of publication; sample size and age of participants, and main results. The data were grouped through a qualitative analysis, which allowed the identification of similarities and establishment of two categories: (1) Nursing care using PICC lines, and (2) Nursing clinical practice related to the use of PICC lines.

Results

Study Characteristics

Out of the 10 selected articles, four were performed in a neonatal unit, two in a neonatal and pediatric unit, and four in a pediatric unit. The smallest study was carried out with 10 nurses who verified the application of the nursing care systematization in the use of PICC; the largest study was composed of 843 catheter insertions and evaluated the use of fluoroscopy.

Eight studies were from Brazil, one from Canada, and one from France. The authors' fields of work in the selected articles were nursing (eight), nursing and medicine (one), and pediatric radiology (one). Although one of the inclusion criteria was having at least one nurse among the authors, we chose to include one article published by a multidisciplinary team of a pediatric radiology service considering its contribution and the lack of information about the authors' field of work, which could include a nurse. The years of publication ranged from 2005 to 2014; one in 2005, one in 2006, one in 2007, one in 2008, two in 2010, two in 2013, and one in 2014.

Thematic Categories

The 10 studies were grouped into two broad categories: (1) Nursing care using PICC lines, and (2) Nursing clinical practice related to the use of PICC lines.

Category 1: Nursing Care Using PICC Lines

Five articles covered this category (Costa et al., 2013; Costa et al., 2010; Onofre, Pereira & Peterlini, 2012; Fricke et al., 2005; Oliveira et al., 2014) that was divided into two subcategories: (1.1.) Nursing care related to pain management and (1.2.) Facilitating methods and strategies in the use of PICC.

1.1. Nursing care related to pain management

Two articles reported about the measurement of pain and pain intervention during PICC insertion (Costa et al., 2013; Costa et al., 2010). The first article reported analgesic or sedative strategies adopted for the PICC insertion. It concluded that analgesic or sedative strategies occurred in only 88 of the 254 insertions (34.6%). The most frequent pharmacological strategies were intravenous administration of midazolam in 47 insertions (18.5%), fentanyl in 19 (7.3%), midazolam + fentanyl in 9 (3.5%), chloral in 5 (2.0%), and Tramadol hydrochloride in 2 (0.8%). The non-pharmacological strategies were: sweetened solution (5 - 2.0%) and sweetened solution + non-nutritive suction (1 - 0.4%). There was no statistically significant difference between the group of neonates who received and those who did not receive any strategy for sedation or pain relief considering the number of punctures, time spent on catheter insertion, and positioning of the PICC tip (Costa et al., 2013).

The second study assessed pain during the central venous catheter peripheral insertion and found that analgesics were not used in 89% of punctures. Among these punctures without analgesia or sedative, the Premature Infant Pain Profile (PIPP) score was greater than or equal to seven indicating moderate to severe pain in 59.1% (13) of newborns in the first venous puncture, and in 45.5% (10) of newborn infants during catheter progression. The results point to the need to adopt analgesic measures because neonates hospitalized in a neonatal intensive care unit are frequently submitted to invasive and painful procedures; the PICC insertion has been confirmed to be one of them (Costa et al., 2010).

1.2. Facilitating methods and strategies in the use of PICC

Three articles contemplated this subcategory (Onofre, Pereira & Peterlini, 2012; Fricke et al., 2005; Oliveira et al., 2014); they described studies that used methods or strategies to facilitate catheter passage. The first study addressed the use of ultrasound as a facilitating method for the insertion of PICC aiming at more accurate and safe punctures by reducing stress, time to perform the procedure, and prevention of catheter repositioning maneuvers. Comparing punctures with or without the use of ultrasound (US), the success rate was 90% in the first attempt in the group that used US compared to 47.6% in the control group. Regarding the correct catheter positioning, punctures using US showed 85.7% success rate compared to only 52.4% in the control group. The time spent with the puncture was also shorter when US were used (20 minutes) compared to the control group (50 minutes) (Onofre, Pereira & Peterlini, 2012).

The second study analyzed 843 consecutively placed pediatric PICCs, of which 723 (85.8%) had a non-central-tip position and required further manipulation. Intermittent fluoroscopic guidance was used for repositioning, which allowed the positioning of the central initial tip of the PICC in 90.2% of PICCs (760) (Fricke et al., 2005).

The third study addressed the possibilities of systematizing the nursing care of using PICC in a university hospital. The results indicated that the systematization of the nursing care should be applied throughout the process of using PICC. In addition, an outpatient service should be created to children that use PICC and their families, so the care can be addressed through the outpatient clinic (Oliveira et al., 2014).

Category 2: Nursing Clinical Practice Related To The Use Of PICC Lines

Five articles were included in this category (Rodrigues, Chaves & Cardoso, 2006; Baggio, Bazzi & Bilibio, 2010; Camargo et al., 2008; Vendramim, Mavilde & Peterlini, 2007; Delarbre et al., 2014) concerning the use of PICC lines in newborns and children, common practice and strategies, complications associated with its use, and main challenges for the nursing team. The first study evaluated the performance of neonatal nurses in the care of PICC lines. Amongst 17 interviewed nurses, nine cited that the basilic vein is the most indicated for catheter placement; all of them (17) mentioned the importance of washing hands before manipulating the device and flushing the catheter, before and after the administration of medications, as the main precaution in PICC line maintenance. The study results showed that there is not enough knowledge about the best vein to place the catheter, and only one participant cited the cephalic vein. When asked about PICC line care, 14 nurses reported changing the dressing due to transparent dressing ruptures, followed by attempting to maintain a sterile environment (13), avoiding catheter damage (12), and preventing catheter migration (06). One participant did not answer the question (Rodrigues, Chaves & Cardoso, 2006).

The second study described the use of PICC in 125 neonatal and pediatric patients, many premature (43.2%) and males (60%). The basilic and cephalic veins were the most used (43.2%), and the 1.9 Fr (*French* = 0.63 millimeters) (85.8%) was the catheter of choice. The success in insertions was high (98.9%), however, the devices had to be removed early due to obstruction (25%), infiltration (18%), contamination (16.6%), catheter traction (13.9%), rupture (11.2%), accidental removal (8.3%), phlebitis (4.2%), cyanosis (1.4%), and migration (1.4%); the average permanence was 14.5 days (Baggio, Bazzi & Bilibio, 2010).

The third study investigated the initial placement of the end of the device in newborns. Amongst the 37 neonates, the success rates were 72.3% (27 newborns); 14.8% (4) had the catheter placed in the auxiliary veins and 11.1% (3) in the jugular vein; these devices had to be removed due to incorrect placement. Thirteen devices (4.2%) had their tip placed in the right atrium; hence they were retracted and repositioned in the superior cava vein (Camargo et al., 2008). The fourth article described the utilization and influences of institutional characteristics when considering PICC line insertion. Part of the nurses worked in private hospitals (57.9%); 61.6% in pediatric and neonatal units. Fifty-two of the participants worked at places where PICC lines were not used. Some of the reasons for not adopting the device were lack of scientific knowledge (83.5%); absence of these type of device in the institution (39.1%), and no clinical recommendation for its use in children (34.8%). Out of all interviewed nurses (410), only 81 (19.9%) reported having performed the procedure in the settings considered for the study (Vendramim, Mavilde & Peterlini, 2007).

The fifth study considered the first 91 PICCs used at a medical hospital and concluded that the procedure was performed using local anesthesia in four cases (4.4%) and topic anesthesia (EMLA and MEOPA) in 87 cases (95.6%). The Ultrasound-Guided PICC placement was performed using the basilic ($n = 63$, 70%), humerus ($n = 18$, 20%), or cephalic ($n=9$, 10%) veins from the non-dominant arm (left arm in 62 cases, right arm in 28 cases). The success rate was 99% ($n=90$). The main indications were: start of antibiotics administration ($n =47$, 52%), chemotherapy ($n = 34$, 38%), and parenteral feeding ($n =5$, 5%). The most common devices used were the 3Fr ($n = 4$, 4%), single lumen 4 Fr ($n = 31.34\%$), double lumen 4Fr ($n = 2$, 2.2%), single lumen 5Fr ($n = 12.13\%$), and double lumen 5Fr ($n =41$, 45%). PICC lines were used for about 45 days and the complications associated with the use of this device were: accidental removing ($n = 2$, 2.2%), catheter fracture ($n = 2$, 2.2%), obstruction ($n = 5$, 5.5%), possible infection ($n = 1$, 1%), and venous thrombosis and embolism ($n = 3$, 3.3%). The global complication rate was 14.4% ($n = 13$) including 4.4% of critical complications ($n = 4$) (Delarbre et al., 2014).

Table 1: Studies included in the review according to author, year, and country of origin, the area of knowledge, purposes, sample size, and main results

Author/Year/Origin /Area	Purpose/Objective	Sample size	Main results
OLIVEIRA et al., 2014. Brazil Nursing	To describe the use of PICC lines in newborns and children.	10 Nurses	The Nursing care systematization (SAE) needs to be applied during the PICC line insertion process. This device is essential for patients that need intravenous therapy. Furthermore, it gives more visibility to the nurse's role and guarantees its autonomy in the context of multidisciplinary work.
DELARBRE et al., 2014. France Multidisciplinary team	To evaluate the establishment of a PICC line service at a medical hospital after the first 91 performed insertions.	91 insertions	The majority of procedures used topic anesthetic, the success rate was 99%, and the main complication was accidental removal.
COSTA et al., 2013. Brazil Nursing	To characterize analgesia and sedation procedures in newborns during PICC line insertion and establish its relationship with the number of venipuncture, duration of the procedure, and catheter tip positioning.	254 PICC lines insertions	The adoption of analgesic or sedative strategies was not widely used. Midazolam was used as anesthesia in 47 (18.5%) patients and Fentanyl in 19 (7.3%) for PICC lines insertions.
ONOFRE et al., 2012. Brazil Nursing	To compare the use of vascular Doppler ultrasound with vein visualization and palpation for positioning peripherally inserted central catheters in children and determine the influence of these methods on the success of the first puncture attempt, catheter positioning, and time required for the insertion.	42 insertions 21 US-Guided and 21 control group	Success in the first puncture attempt was higher ($p = .003$) in the ultrasound group (90.5%) than in the control group (47.6%). The use of ultrasound increased the rate of the successful positioning of peripherally inserted central catheters in comparison with the venous anatomic landmark visualization and palpation technique; it further optimized the time spent on the procedure.
COSTA et al., 2010. Brazil Nursing	To characterize analgesia and sedation strategies in neonates having a peripherally inserted central catheter (PICC) placed, and to relate it to the number of venipuncture, duration of the procedure, and catheter tip position.	28 newborns	Different analgesics were used in 89% of insertions. The PIPP score indicated pain from mild to intense in 13 NB in the first puncture and in 10 NB during catheter insertion in the group that had not received analgesics or sedatives.
BAGGIO et al., 2010. Brazil Nursing	To describe the use of peripherally inserted central catheter (PICC) in a neonatal and pediatric intensive care unit regarding their insertion, maintenance, and removal. This study also characterized the population that had the catheter implanted.	176 instruments filled out by nurses, in a two-year period	The basilic and cephalic veins were the most used to place the device (43.2%), and the 1.9 Fr (85.8%) was the most common lumen gauge size. The most frequent cause of early removal was an obstruction (25%) followed by infiltration (18%).
CAMARGO et al., 2008. Brazil Nursing	To identify the initial positioning of the PICC tip and verify the prevalence of success during catheter insertion in newborns.	37 newborns	The success rates during the procedure were 72.3% (27 newborns); amongst them, four were removed due to changes in its placement.
VENDRAMIM 2007. Brazil Nursing	To describe the use of PICC in hospitals in São Paulo and verify the influence of the institutional characteristics regarding the use of the device.	410 nurses	52% of nurses worked at places where PICC lines were not used. The main reason for that was a lack of scientific knowledge to guide the use of this device.
RODRIGUES et al., 2006. Brazil Nursing	To investigate the nurses' performances regarding PICC line care in high-risk newborns in a neonatal unit.	17 nurses	The basilic vein was the most appropriate vein for catheter placement. The most common care recommendations were: hand washing before and after manipulating the device and flushing the catheter before and after the administration of medications.
FRICKE et.al., 2005. Canada Nursing and Medicine	To determine how often placement of peripherally inserted central catheters (PICCs) without imaging guidance results in an initially correct central venous catheter tip location.	843 PICC insertions	Without fluoroscopy, 85.8% of procedures needed additional manipulation. By having fluoroscopy guidance, 90.2% succeeded in the first attempt.

Discussion

This review allowed the observation that nursing knowledge and care regarding the use of PICC in pediatrics can be summarized in two major points: pain management and the use of facilitating methods in the use of PICC.

Several of the selected studies addressed pain management during invasive procedures. Despite the need to consider pain as the fifth vital sign, this practice is still little disseminated in health teams. Few hospitals have protocols for the evaluation of pain and non-pharmacological intervention to be conciliated with pharmacological therapy in the attempt to alleviate trauma and stress during hospitalization, especially when it comes to children (Costa et al., 2013; Costa et al., 2010). The articles in this study showed limited numbers related to the use of analgesia to perform the PICC insertion. A quantitative study with 15 nurses from a Neonatal Unit found that despite the fact that they use pharmacological and non-pharmacological therapies, there is no protocol for the evaluation and treatment of pain in the studied unit (Presbytero, Costa & Santos, 2010). This finding was not an exception because several hospitals still need to improve the handling of pain in pediatric settings.

The use of new technologies, such as ultrasound, in the procedure to access central venous was one facilitating methods reported in the use of PICC; it reduces the risk of vascular lesions, pneumothorax, bleeding, and trauma among other benefits. Moreover, studies have demonstrated efficiency and efficacy in relation to the reduction of time spent in the procedure, reduction in number of punctures (90% success rate on the first attempt), and initial central location of the catheter tip significantly reducing errors when compared to anatomical knowledge and procedure complications (Onofre, Pereira & Peterlini, 2012; Fricke et al., 2005; Oliveira et al., 2014; Zanolli, 2014).

In the use of PICC in the clinical practice, a study with adults performed at the Intensive Care Center found that 65% used the basilic vein followed by the cephalic vein (25%) for the insertion of 40 PICCs; similar reports were observed in most of the neonatology and pediatric studies evaluated in this review. It was also concluded that despite being a safe and low infection rate procedure, constant training of the nursing team is necessary in order to avoid complications due to inadequate device manipulation (Lambert et al., 2005). In pediatrics, many places still have restrictions on the use of PICC due to the lack of training in PICC insertion and care.

Conclusion

Few studies about the use of PICC lines in neonatology and pediatrics were found in the last 10 years, especially in terms of procedure and care. Brazilian nurses conducted the majority of the studies presented in this review. The incorporation of new technologies has enhanced the use of PICC lines decreasing the length of insertions, complications, and risks to patients. However, the lack of knowledge about catheter insertion, maintenance, and care is still some of the obstacles to its wide use. The constant knowledge update provided to nurses is necessary to improve their clinical practice associated with the use of this device.

Despite the relevance of pain studies in neonatology and pediatrics, pain management during the insertion of PICC lines is still an underexplored topic in the literature that can be considered a challenge in the implementation of the use of this procedure in these patients.

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