

Peripherally inserted central catheter in pediatric oncology: a scoping review

Cateter venoso central de inserção periférica em oncologia pediátrica: revisão de escopo

Catéter venoso central de inserción periférica en oncología pediátrica: revisión del alcance

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Abstract

Objective: To map the scientific production about the use and maintenance of peripherally inserted central catheter (PICC) in children and adolescents undergoing oncology treatment.

Methods: Scoping review, according to the method adapted and proposed by Levac, Colquhoun and O'Brien. Five stages were performed: identification of the research question; search for relevant studies; selection of studies; extraction of the data; grouping, summarizing and presenting the results. The databases used were PubMed, CINAHL, Scopus, LILACS and Embase. Literature review articles or original articles were included, with qualitative or quantitative designs, which focused on peripherally inserted central catheters in children and adolescents, in any stage of the oncology treatment and care context, published in Portuguese, English and Spanish, between 2006 and 2017.

Results: Searches in the databases returned 609 unique articles, nine of which constituted the final sample. Five main themes were elaborated related to the use of the peripherally inserted central catheter: indication, insertion technique, catheter maintenance, related complications and outcomes of the use. Based on the results, the recommendations for the use of this device can be summarized, mainly related to: the treatment and type of neoplasm, selected veins, dressing types, main complications and outcomes.

Conclusion: The peripherally inserted central catheter is a safe and reliable option for intravenous therapy in the pediatric oncology population. This study contributes to evidence the indication of its use for that population and appoints themes for future empirical studies.

Resumo

Objetivo: Conhecer a produção científica sobre a utilização e manutenção do cateter central de inserção periférica (CCIP) em crianças e adolescentes em tratamento oncológico.

Métodos: Revisão do tipo *Scoping Review*, segundo o método adaptado e proposto por Levac, Colquhoun e O'Brien. Foram percorridas cinco etapas: identificação da questão de pesquisa; buscas por estudos relevantes; seleção de estudos; extração dos dados; agrupamento, resumo e apresentação dos resultados. Utilizaram-se as bases de dados PubMed, CINAHL, Scopus, LILACS e Embase. Foram incluídos artigos de revisão da literatura ou originais, de abordagem quantitativa ou qualitativa, que focalizassem o cateter venoso central de inserção periférica em crianças e adolescentes com câncer, em qualquer fase do tratamento oncológico e contexto de cuidado, publicados em português, inglês e espanhol, no período de 2006 a 2017.

Resultados: Buscas nas bases de dados capturaram 609 artigos únicos, dos quais nove compuseram a amostra final. Foram elaborados cinco temas principais relacionados à utilização do cateter venoso central de inserção periférica: indicação, técnica de inserção, manutenção do cateter, complicações relacionadas e desfechos do uso. Os resultados permitem sintetizar as recomendações para a utilização deste dispositivo no que se refere, sobretudo, a: terapêutica e tipo de neoplasia, veias de escolhas, tipos de curativos, principais complicações e desfechos.

Conclusão: O cateter venoso central de inserção periférica mostra-se uma opção segura e confiável para a terapia endovenosa na população pediátrica oncológica. O presente estudo contribui por tornar clara a indicação de sua utilização para tal população e apontar temas a serem explorados em futuros estudos empíricos.

Resumen

Objetivo: Conocer la producción científica sobre la utilización y mantenimiento del catéter central de inserción periférica (CCIP) en niños y adolescentes en tratamiento oncológico.

Método: Revisión tipo *Scoping Review*, según el método adaptado y propuesto por Levac, Colquhoun y O'Brien. Se realizaron cinco etapas: identificación del tema de investigación; búsquedas de estudios relevantes; selección de estudios; extracción de datos; agrupación, resumen y presentación de los resultados. Se utilizaron las bases de datos PubMed, CINAHL, Scopus, LILACS y Embase. Fueron incluidos artículos de revisión bibliográfica u originales, de enfoque cuantitativo o cualitativo, que se centraran en el catéter venoso central de inserción periférica en niños y adolescentes con cáncer, en cualquier etapa del tratamiento oncológico y cualquier contexto de cuidado, publicados en portugués, inglés y español, en el período de 2006 a 2017.

Resultados: En las búsquedas en las bases de datos se encontraron 609 artículos únicos, de los cuales nueve formaron parte de la muestra final. Fueron elaborados cinco temas principales relacionados a la utilización del catéter venoso central de inserción periférica: indicación, técnica de inserción, mantenimiento del catéter, complicaciones relacionadas y resultados de uso. Los resultados permiten sintetizar las recomendaciones para la utilización de este dispositivo respecto, sobre todo, a: uso terapéutico y tipo de neoplasia, elección de venas, tipos de vendaje, principales complicaciones y resultados.

Conclusión: El catéter venoso central de inserción periférica muestra ser una opción segura y confiable para terapia endovenosa en la población pediátrica oncológica. El presente estudio ayuda a esclarecer la indicación de su utilización para tal población y señala temas que serán analizados en futuros estudios empíricos.

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Introduction

The peripherally inserted central catheter (PICC) is commonly used to access the central venous network of children and adolescents.⁽¹⁾ Its use has increased over the years, mainly in cancer patients, for the administration of intravenous chemotherapy, which is one of the most used treatment modalities.^(2,3) In Brazil, the PICC can be inserted by qualified physicians or nurses who are duly qualified and skilled, according to COFEN Resolution 258/2001.⁽⁴⁾ The increase in the number of nurse-led themes in this procedure has made the PICC more accessible and convenient in different contexts.⁽²⁾ Although the health professionals follow institutional protocols for the insertion and maintenance of this device, in Brazil, the National Cancer Institute José de Alencar Gomes da Silva (INCA) offers a manual with the best practices for PICC insertion and management.⁽⁵⁾

The preference for the use of PICC mainly stems from the possibility of being inserted in the ward, without the need for a surgical procedure. In addition, its cost is lower when compared to other catheters, such as the short-term central catheter, also used in infusions of hemotherapy, chemotherapeutic drugs, parenteral nutrition and collection of blood samples.⁽⁶⁾ The use, advantages and complications of PICC are discussed in several studies, especially with the adult population in an outpatient or inpatient setting⁽⁷⁾ and patients diagnosed with cancer.⁽⁸⁾ There are even systematic narrative reviews⁽⁹⁾ and meta-analyses on the subject with adults⁽¹⁰⁾, as well as several studies with neonates.⁽¹¹⁻¹⁴⁾ There are no literature reviews about the use of PICC in pediatrics,^(15,16) especially in a specific condition such as cancer.

In this sense, it is necessary to gather the scientific evidence on the use of CCIP and its importance in the context of pediatric oncology, in order to support the practice of nurses and physicians and bring new perspectives to research, mainly because it is a preferred catheter for the infusion of chemotherapeutic drugs. Therefore, this study aims to map the scientific production on the use

and maintenance of the peripherally inserted central catheter in children and adolescents undergoing cancer treatment.

Methods

In order to conduct the literature review, we opted for the scoping review method, which investigates key concepts underlying a research area, provides a map of the available evidence and identifies gaps in the knowledge base when other specific aspects on the theme are not clear.⁽¹⁷⁾ Five stages were executed: identification of the research question (“What scientific evidence is found about the use and maintenance of PICC in children and adolescents undergoing cancer treatment?”); search for relevant studies; selection of studies; extraction of data; and grouping, summary and presentation of the results.^(17,18)

The PCC strategy (P: Population, C: Concept and C: Context) was adopted to elaborate the research question and search strategy.⁽¹⁷⁾ Two reviewers independently performed the searches in March 2017, which were updated in April 2018, in PubMed, CINAHL, Scopus, LILACS and Embase. The descriptors used were Child; Adolescent; Neoplasms; Peripherally Inserted Central Catheter Line Insertion and their corresponding keywords. In order to maintain coherence in the search for articles and to avoid possible biases, the descriptors and the keywords were used in isolation and associated, respecting the specific characteristics of each of the selected databases. The searches were limited to the period from 2006 to 2017, given the purpose of identifying the most recent evidence on the use of PICC in clinical practice. Manual searches were performed in the references of the included studies in order to locate relevant studies, but there was no contact with the authors to identify additional studies.

We included literature review or original articles, with quantitative or qualitative designs, which focused on PICC in children and adolescents, at any stage of cancer treatment and in any

care context, published in Portuguese, English, and Spanish. Guidelines and articles that discuss the use of PICC in newborns and adults, treatment of conditions other than cancer, or the results related to PICC were not presented distinctly from other catheters. The titles and abstracts of the articles found were organized into a Microsoft Office 2013 EXCEL spreadsheet and duplicates were removed. Two independent reviewers selected the articles by reading titles and abstracts to identify those relevant.

Both reviewers fully read the selected articles based on the eligibility criteria in order to select the final review sample. The data of these study were extracted based on the form of the Cochrane Consumer and Communication Review Group⁽¹⁹⁾ and analyzed independently by two reviewers. The information on the articles' authorship and year of publication, method, main results and implications were used and are described in Picture 1 and in the qualitative synthesis of the studies. These data were extracted according to the recommendations by Arksey and O'Malley.⁽¹⁷⁾ Three researchers analyzed the data descriptively and elaborated main themes to facilitate a general and comprehensive view of the literature. We chose to present a synthesis of the main characteristics of the analyzed studies and result themes.

Results

Searches in the databases returned 711 articles, while two were found after analyzing the references of the included studies. On the other hand, 104 repeated publications were excluded, totaling 609 unique files. The titles and abstracts were screened based on the eligibility criteria, which led to the exclusion of 587 publications, as they explored the use of other catheter types or the use of PICC in a population beyond the pediatric oncology context. At the end, 22 articles remained which were fully read. The final sample of the review consists of nine articles (Figure 1).

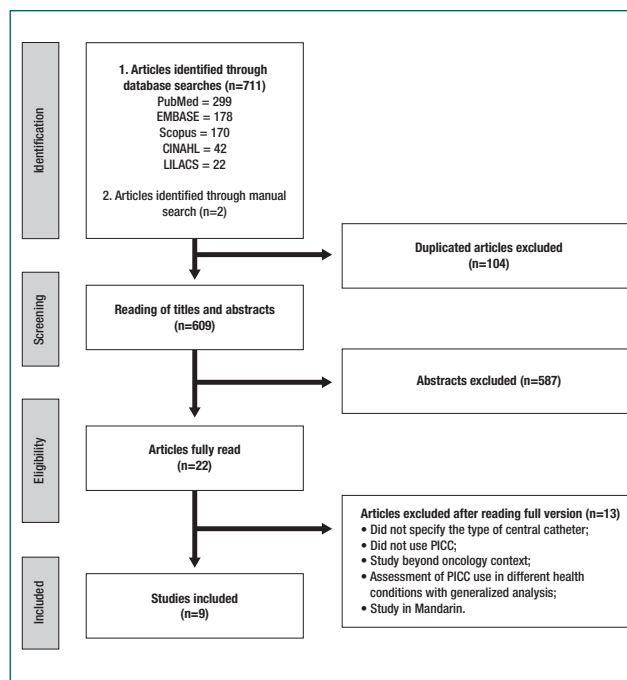


Figure 1. PRISMA flowchart⁽²⁰⁾ of literature search process

Study characteristics

Chart 1 presents the main characteristics of the studies included.

Qualitative synthesis of the studies: use of PICC

Figure 2 presents the five themes constructed based on the analysis of the results of the included studies.

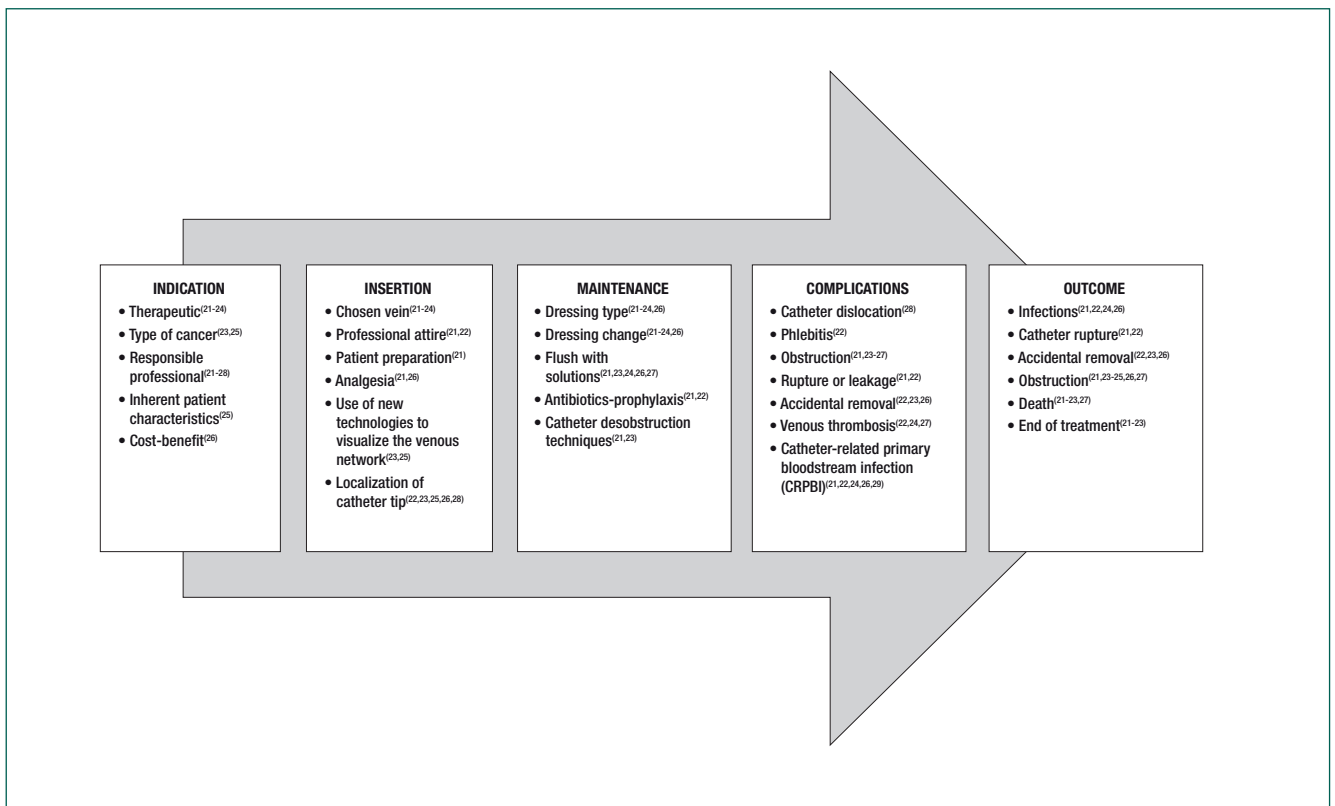
Indication for insertion

In some studies, PICC was indicated for prolonged infusion of intravenous fluids, total parenteral nutrition, antineoplastic agents, antibiotics and blood products.^(21,23) Others proposed that it be used according to the treatment protocol⁽²³⁾ and, for the sake a more assertive choice, the professionals should take into account the patient's needs and opinions, as well as the length of the treatment, according to the pre-established protocol.⁽²⁵⁾ Studies analyzed also show that, when indicating PICC, the professional should consider the patient's type of cancer,^(23,25) for example solid or hematological, although they did not mention how to make this decision based on tumor differentiation.

In six studies^(21,23,25-28), the physician was mentioned as the most qualified professional for the in-

Chart 1. Main characteristics of the studies included in the review

Primary Authors, Year, Country	Objective	Method	Professionals responsible for PICC insertion	Participants
Matsuzaki, ⁽²¹⁾ 2006 Japan	Assess the feasibility of the PICCs and determine the risk factors and complications related to PICC in pediatric cancer patients.	Longitudinal study	Pediatricians	Group of 53 patients with a mean age of 5 years, weight between 10kg and 20kg, diagnosed with cancer.
Shen, ⁽²²⁾ 2009 China	Assess the feasibility of the PICCs and determine the catheter-related complication rate in pediatric cancer patients.	Observational study	Nurses	Sample of 119 patients, mean age between 5 and 10 years, weight between 10kg and 20kg, with solid and hematological neoplasms.
Hatakeyama, ⁽²³⁾ 2011 Japan	Assess the characteristics of the PICC patients, as well as the dwelling time, reasons for withdrawal of the device and complications.	Retrospective study	Pediatricians	78 patients in total, mean age between 5 and 10 years, weight between 20kg and 50kg, diagnosed with solid and hematological neoplasms.
Bergami, ⁽²⁴⁾ 2012 Brazil	Describe the insertion, maintenance and withdrawal practices of the PICC at the pediatric hospital-based oncology service.	Descriptive and retrospective study	Nurses	Sample of 160 patients, with a mean age of 10 years, diagnosed with malign neoplasms.
Crocoli, ⁽²⁵⁾ 2015 Italy	Provide practical recommendations for the indication, choice, implementation and withdrawal of long and medium-term catheters in pediatric onco-hematological patients, including orientations about the prevention of early and late complications potentially related to the insertion of venous devices.	Narrative review	Pediatric surgeons	Pediatric patients diagnosed with cancer.
Fadoo, ⁽²⁶⁾ 2015 Pakistan	Assess the feasibility of PICCs and determine complications related to the use in pediatric oncology and hematology patients.	Observational study	Pediatricians	Group of 36 patients younger than 16 years with hematological and neoplastic conditions.
Yacobovich, ⁽²⁷⁾ 2015 Israel	Describe risk factors for central catheter-related bloodstream infection in pediatric patients with cancer or submitted to bone marrow transplantation in cases of non-malign disease.	Prospective study	Pediatricians	Sample of 262 patients, with a mean age of 7.4 years and solid tumors.
Rajan, ⁽²⁸⁾ 2016 India	Report the experience of inserting a PICC when, after its insertion, it was observed that the tip was located in the jugular vein but, after 24 hours, it had migrated to the superior vena cava.	Experience report	Anesthetists	A three-year-old girl diagnosed with acute lymphocytic leukemia.
Moskalewicz, ⁽²⁹⁾ 2017 United States	Examine the clinical characteristics associated with bacteremia in non-neutropenic pediatric cancer patients with fever using central catheters at the emergency service.	Retrospective cohort study	Not reported	Sample of 246 patients between 4 and 12 years of age, diagnosed with cancer. The majority presented acute lymphoid leukemia.

**Figure 2.** Synthesis of evidence on the use of PICC in children and adolescents undergoing oncology treatment

sersion of the PICC and, in only two,^(22,24) the nurse, provided that (s)he was duly qualified for this procedure. In addition, the device insertion revealed low complication rates compared to other conventional central catheters.⁽²⁶⁾

Insertion technique

The included studies⁽²¹⁻²⁴⁾ cited the following preferred veins for the insertion of PICC: basilic, cephalic and median cubital, in the antecubital fossa. The basilic vein was indicated as a preferred vein because it presented lower complication rates.⁽²²⁾ The laterality of the chosen limb was based on the patient's opinion, preferably in the non-dominant arm.^(21,23)

Two studies^(21,26) indicated the use of pain relief measures prior to the initiation of venipuncture. In one,⁽²¹⁾ the PICC insertion procedure was performed under intravenous sedation and, in the other,⁽²⁶⁾ by local or intravenous analgesia by an interventional radiology team.

Complete surgical attire was indicated, i.e. mask, cap, sterile gloves and sterile aprons for the insertion of the PICC.^(21,22) Then, the patient's skin antisepsis was performed using iodopovidone solution and the limb to be punctured was covered with sterile surgical drapes⁽²¹⁾ The indication for vein access should be by palpation and/or visualization,^(21,22) by fluoroscopy, through the guided image,⁽²³⁾ or by means of an ultrasound device.⁽²⁵⁾ After skin antisepsis, an introducer for venipuncture was used, i.e. the catheter should be inserted into the lumen of the vein with an internal metal needle covered by a plastic cover.⁽²¹⁾ After verification of the blood return, the metal needle was removed, leaving only the plastic material in the lumen of the vein, through which the catheter was inserted.⁽²¹⁾ At the end of the insertion, the introducer was removed, the skin antisepsis was again performed using iodopovidone and the catheter was occluded with sterile transparent film.⁽²¹⁾

Some studies have recommended that the tip of the catheter be positioned in the superior vena cava when inserted in upper limbs.^(22,23,26,28) A survey⁽²⁵⁾ alerted that the tip should be located at the junction

of the superior vena cava with the right atrium and another indicated the interior of the right atrium.⁽²²⁾

Maintenance

Authors^(21-24,26) recommended the use of a sterile, transparent and moisture-sensitive adhesive tape for the dressing on the PICC insertion, which should be changed weekly, provided that the dressing was intact.

The permeability of the catheter after its use was maintained with parenteral solutions, with heparin being the most used,^(21,23,24,26,27) but without consensus on the concentration and volume to be infused in the catheter. Two studies indicated the concentration of 10 IU/ml but without specifying the volume.^(21,23) In another,⁽²²⁾ 5 ml was used with the concentration of 0.4 IU/ml and, in the only Brazilian study, the volume of 0.6 and 0.5 ml of heparin at a concentration of 5000 IU/ml was infused into the catheter lumen, depending on the caliber of the device.⁽²⁴⁾ In addition to the heparin solution, the catheters had their permeability maintained with a flush of 0.9% physiological solution⁽²²⁾ and using a solution commercially known as Cath Safe®.⁽²⁴⁾ Regarding antibacterial prophylaxis, one study recommended the prophylactic administration of second-generation cephalosporin for three days after insertion of CCIP.⁽²¹⁾ In addition, patients with febrile neutropenia were treated with fourth-generation cephalosporin associated with another antibiotic or antifungal agent indicated for each specific pathogen.⁽²¹⁾ One study⁽²²⁾ did not recommend antibiotic prophylaxis in case of febrile neutropenia though.

In view of PICC obstruction, two studies indicated the administration of urokinase, a fibrinolytic agent, at a concentration of 6,000 IU/ml.^(21,23) In one, the recommended time for the agent to remain in the catheter lumen was 30 minutes⁽²¹⁾ and in the other case, 90 minutes.⁽²³⁾ After this period, the solution should be aspirated and the permeability of the catheter tested.^(21,23)

In addition to all the measures adopted for PICC maintenance, the training of the nursing team is considered important to ensure a longer useful life of the device and a minimum of complications.⁽²²⁾

Complications

Studies have related the material and caliber of the catheter with a higher incidence of venous thrombosis.^(22,24,27) Another complication identified was the migration from the catheter tip to the internal jugular vein rather than remaining in the superior vena cava.⁽²⁸⁾ Nevertheless, it was still decided not to remove the device and, after 24 hours, the radiological image was repeated, which confirmed the proper positioning of the PICC.⁽²⁸⁾

Of the several complications, Catheter-Related Primary Bloodstream Infection (CRPBI) was the most important and the one that most resulted in PICC withdrawal. The most frequent microorganisms associated with bloodstream infection were *Staphylococcus aureus* and *Staphylococcus epidermidis*.^(21,22,24,26,29)

Regarding the type of neoplasia, in two studies, it was observed that patients with Acute Myeloid Leukemia (AML) were more likely to suffer from complications related to PICC use.^(21,27) One of them pointed out that, from the viewpoint of microbiological findings, AML patients were at a higher risk of contracting gram-positive bacterial infections compared to other types of tumors.⁽²⁷⁾

Factors related to fluid infused in the PICC lumen did not influence the development of catheter-related infections, but there was a higher incidence of infections in patients who received blood transfusion or transplanted stem cells.⁽²¹⁾ The following complications were also reported: catheter dislocation,⁽²²⁾ phlebitis,⁽²²⁾ obstruction,^(21, 23-27) rupture or leakage^(21,22) and accidental removal.^(22,23,26)

Outcome

One of the arguments to remove PICC was the percentage of deaths of patients undergoing treatment,^(21-23,27) which in the analyzed studies ranged from 12.4%⁽²²⁾ to 16%.⁽²⁷⁾ Termination of treatment was another motive that justified the PICC withdrawal.⁽²¹⁻²³⁾ Other reasons cited for the removal of PICC were catheter rupture,^(21,22) accidental removal^(22,23,26), and obstruction.^(21,23-27) In the studies^(21,22,24,26,27) that mentioned the dwelling time of the PICC, it ranged from three⁽²¹⁾ to 669⁽²⁷⁾ days (22.3 months), with a maximum average of 446 days.

Discussion

This review gathered scientific evidence on the use of PICC in children and adolescents undergoing cancer treatment, mainly with regard to: indication, insertion, maintenance, complications and use outcomes.

The indication of the use of PICC in children and adolescents undergoing cancer treatment is clearly determined to guarantee a lasting venous access to the patient, with low complication rates. In addition, it can be inserted by a qualified professional at the patient's bedside. The contraindication of peripheral venous catheters in patients undergoing antineoplastic chemotherapy is observed in the literature, as the extravasation of these drugs in the tissues adjacent to the catheter insertion site can lead to unfavorable outcomes such as: tissue necrosis, physical and psychological disorders.⁽³⁰⁾

In none of the studies analyzed, internationally recognized guidelines, such as those of the Centers for Disease Control and Prevention,⁽³¹⁾ were used to establish institutional protocols that ensure uniformity in issues related to PICC, especially with regard to catheter insertion and maintenance in order to minimize the occurrence of damage, for example, in relation to the preparation of the patient's skin. In this sense, it is important for the health professionals to know the guidelines so that they can support clinical practice and, consequently, ensure quality care.

In one of the studies,⁽²¹⁾ the authors reported using the iodopovidone solution for skin antisepsis in children and adolescents, prior to the passage of the PICC. This is a practice without sufficient scientific evidence to support the use of a particular antiseptic solution in terms of safety and efficacy though. The most indicated solutions are iodopovidone and chlorhexidine, both in alcoholic preparations.⁽³¹⁾

The complications related to the use of PICC mentioned in this review were: catheter dislocation, phlebitis, occlusion, rupture or leakage, accidental removal, venous thrombosis and, more frequently, CRPBI. Another study,⁽³²⁾ involving 1807 children with diverse diagnoses, found similar results, based on which it can be inferred that complications re-

lated to PICC can occur independently of the oncological diagnosis.

A predominance of studies in the medical area is observed as, in general, doctors are responsible for the insertion of PICC. Research⁽³³⁾ performed to compare the cost of insertion, patient satisfaction and infection rates of PICCs inserted by trained nurses and radiologists identified a much higher expenditure when the procedure was performed by radiologists and greater patient satisfaction when performed by nurses. In addition, the results showed that the insertion by radiologists was not more successful in relation to the procedure performed by nurses, and the infection rates were higher for the catheters inserted by radiologists. Thus, the study concluded that most PICCs can be inserted without an x-ray machine, safely and in a protected environment.⁽³³⁾ Another study⁽³⁴⁾ reinforced that the use of new technologies for visualization of the blood vessel during venipuncture does not provide better results when compared to visualization and venous palpation.⁽³⁴⁾

Also with regard to the catheter insertion, the nurse's skills to insert the catheter are insufficient, as the entire team has to be able to provide the necessary care and ensure the proper maintenance of the device,⁽²²⁾ in order to avoid damage and allow it to dwell as long as possible, preferably until the end of treatment. In addition, the patient should be empowered to know this intravenous device and understand the care it requires, for example, dressing change routine, maintenance of catheter permeability using saline infusion and heparin solutions (according to the institutional protocol), even after hospital discharge.

Regarding the country where the studies were carried out, there is a predominance of research developed in China and Japan. Although the insertion of PICC in cancer patients was stimulated in Brazil after the incorporation of groups of catheters into treatment reference centers,⁽⁵⁾ only one study presented results on the use of this device in Brazilian children and adolescents undergoing cancer treatment.⁽²⁴⁾

Although the results of this review are not specifically related to nursing care, they permit priority

setting for PICC care in the context of pediatric oncology nursing. Although the literature shows the benefits of using these catheters, fewer than half of the nurses interviewed reported using them in clinical practice.⁽³⁵⁾ In this sense, it is necessary to widely disseminate the benefits of PICC in relation to other types of non-central or central catheters, in order to spread their use by nurses.

The results of this review should be considered in the context of limitations and strengths. The subject is still incipient in the literature, as only nine articles were found in the five databases consulted. In addition, scientific evidence on catheter insertion and maintenance techniques cannot be generalized because of the lack of both uniformity and detailed description in the included studies. Despite these limitations, however, this review has the potential to foster and support further research, as it demonstrates the need for broader research, such as randomized clinical trials, to increase scientific evidence and to ground clinical practice.

Studies describing the technique of PICC insertion, the best dressing to be applied to the catheter insertion site and the best solution to be infused into the PICC lumen to ensure its permeability are the main knowledge gaps identified in this review.

Conclusion

PICC has been shown to be a viable catheter and therefore a safe and reliable option for intravenous therapy in the pediatric oncology population. Despite the scarce number of studies identified and analyzed in the period from 2006 to 2017, the recommendations for the use of the catheter could be summarized with regard to: indication, insertion, maintenance, complications and outcomes of the use. This review evidenced gaps in the conduct of research worldwide, and mainly in the Brazilian context, despite the use of PICC in the clinical practice of Brazilian nursing. The clarity of the PICC indication for the pediatric oncology population and the recommendation of themes to be explored in future empirical studies are the strengths of this review and may support the practice of nurses and

guide future studies involving the pediatric oncology population.

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