

COMPLICATIONS OF PERIPHERALLY INSERTED CENTRAL CATHETER: INTEGRATIVE REVIEW

COMPLICAÇÕES DO CATETER CENTRAL DE INSERÇÃO PERIFÉRICA: REVISÃO INTEGRATIVA

COMPLICACIONES DE CATÉTER CENTRAL DE INSERCIÓN PERIFÉRICA: REVISIÓN INTEGRADORA

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ABSTRACT

Objective: to identify the complications related to the use of Peripherally Inserted Central Catheter (PICC). **Method:** integrative literature review, whose search for articles was performed in the databases CINAHL, Cochrane, Embase, VHL/Medline, and PubMed on 07/07/21, by combining MESH terms and the Boolean operators AND for different descriptors and OR for similar descriptors. The included studies were evaluated and categorized according to the levels of evidence. **Results:** 904 studies were retrieved, and seven of these were included. Complications are classified as local (phlebitis, infection, and thrombosis) in six (85.7%) studies; systemic (bacteremia) in one (14.3%) study and circumstantial (occlusion, malposition, rupture, accidental removal, bleeding, dermatitis, external breakage, and hematoma) in five (71.4%) studies. Care related to prevention, diagnosis, and treatment was identified. **Conclusion:** This review identified a low incidence of complications related to the use of PICC, among the most frequent are inadequate positioning (9.6%), occlusion (8.8%), phlebitis (8.3%), accidental removal (4.9%), and infection (4.3%). Care for the prevention and early diagnosis of complications is fundamental in managing these devices.

Descriptors: Catheterizations, Peripheral Venous; Nursing Care; Secondary Prevention.

RESUMO

Objetivo: identificar as complicações relacionadas ao uso de Cateter Central de Inserção Periférica (PICC). **Método:** revisão integrativa da literatura, cuja busca dos artigos foi realizada nas bases *Cinahl*, *Cochrane*, *Embase*, *BVS/Medline*, *Pubmed* em 07/07/21, pela combinação de *MESH terms* e dos operadores booleanos AND para descritores diferentes e OR para descritores similares. Os estudos incluídos foram avaliados e categorizados de acordo com os níveis de evidência. **Resultados:** foram recuperados 904 estudos, destes, sete foram inclusos. As complicações são classificadas em locais (flebite, infecção e trombose) em seis (85,7%) estudos; as sistêmicas (bacteremia) em um (14,3%) estudo e circunstanciais (oclusão, mau posicionamento, ruptura, remoção acidental, sangramento, dermatite, quebra externa e hematoma) em cinco (71,4%) estudos. Identificaram-se os cuidados relacionados à prevenção, ao diagnóstico e ao tratamento. **Conclusão:** nesta revisão identificou-se a baixa incidência de complicações relacionadas ao uso do PICC, dentre as mais frequentes estão o posicionamento inadequado (9,6%), a oclusão (8,8%), a flebite (8,3%), a remoção acidental (4,9%) e a infecção (4,3%). Os cuidados para a prevenção e o diagnóstico precoce das complicações são fundamentais no manejo destes dispositivos.

Descritores: Cateterismo Venoso Periférico; Cuidados de Enfermagem; Prevenção Secundária.

RESUMEN

Objetivo: identificar las complicaciones relacionadas con el uso del Catéter Central de Inserción Periférica (PICC). **Método:** revisión integradora de la literatura, cuyos artículos fueron buscados en las bases *Cinahl*, *Cochrane*, *Embase*, *BVS/Medline*, *Pubmed* el 21/07/07, combinando términos *MESH* y operadores booleanos AND para descriptores diferentes y OR para descriptores similares. Los estudios incluidos se evaluaron y clasificaron según los niveles de evidencia. **Resultados:** se recuperaron 904 estudios, de los cuales se incluyeron siete. Las complicaciones se clasifican según sitios (flebitis, infección y trombosis) en seis estudios (85,7%); las sistémicas (bacteriemia) en un estudio (14,3%) y las circunstanciales (oclusión, mal posicionamiento, rotura, extracción accidental, sangrado, dermatitis, rotura externa y hematoma) en cinco estudios (71,4%). Se identificaron cuidados relacionados con la prevención, el diagnóstico y el tratamiento. **Conclusión:** en esta revisión se identificó una baja incidencia de complicaciones relacionadas con el uso del PICC,

entre las más frecuentes se encuentran el posicionamiento inadecuado (9,6%), la oclusión (8,8%), la flebitis (8,3%), la extracción accidental (4,9%) y la infección (4,3%). Los cuidados para la prevención y el diagnóstico precoz de las complicaciones son fundamentales en el manejo de estos dispositivos.

Descriptores: Cateterismo Venoso Periférico; Atención de Enfermería; Prevención Secundaria.

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INTRODUCTION

The Peripherally Inserted Central Catheter (PICC) is a widely used intravenous device since it allows a prolonged stay in the patient, is easy to install and has lower risks of complications when compared to other vascular devices, inserted using the Seldinger technique.¹

In Brazil, the PICC began to be used only in neonates, later its use was spread to all age groups.² The PICC is recommended for patients in need of deep venous access for a prolonged duration, and can be used for drug administration, parenteral nutrition, and blood-based products, also allowing the collection of blood for laboratory sampling.³

The PICC presents numerous benefits, among them the possibility of its permanence in prolonged treatment, thus reducing the need for repeated peripheral punctures and with low risk of contamination when compared to central devices, and providing greater patient comfort.³ Another advantage is the possibility of catheter insertion at the bedside, not requiring a surgical environment.⁴ It is worth reminding that trained/habilitated professionals must insert the PICC, and the puncture can be guided or not by ultrasound.³

The insertion of the PICC is associated with decreased risk of pneumothorax and hemothorax by central punctures and with lower cost, when compared to other central catheters, such as the Central Venous Catheter (CVC).³ Despite presenting numerous benefits, the use of the PICC is also associated with the risk of complications, as with other vascular and/or invasive devices. Authors^{4,5} have classified complications associated with the use of PICC in different ways; these can be categorized as local, systemic, or circumstantial⁵, as well as separated regarding time, as immediate, early, or late.⁴

Although complications are less prevalent, they are associated with higher costs, delayed treatment, the need for more interventions, and longer hospital stays.³ In this scenario, the nursing team becomes fundamental, since it acts from the indication of the device until its removal.⁶

There are few studies on the specific care related to the prevention of complications for the PICC, the approach on the care of Central, Deep, and Peripheral Venous Accesses (PVA) being the most common.^{7,8} Therefore, Nursing should always seek the quality of care provided and should not only consume but also produce scientific knowledge that can benefit patient care. This study aimed to identify complications related to the use of Peripherally Inserted Central Catheters (PICC).

METHOD

This is an integrative literature review that sought to answer the following research question: What is the frequency of complications related to the use of PICC, and what are the precautions listed in the literature for the management of these complications? To elaborate the research question, the PICO strategy was used, which is an acronym for Patient, Intervention, Comparison, and Outcomes; the study development follows the steps of an integrative review.⁹

The study was conducted following the steps proposed by Mendes, Silveira, and Galvão:⁹ 1) formulation of the research question; 2) specification of study selection methods; 3) data extraction procedure; 4) critical analysis and assessment of the studies included; 5) data extraction, and 6) presentation of the integrative review of the knowledge produced/published.

The search was conducted in the Cinahl, Cochrane, Embase, *Biblioteca Virtual em Saúde* (BVS)/Medline and Pubmed NHI databases on July 7, 2021. The search strategy occurred using the Medical Subject Headings (MESH terms): "adult", "child", "nursing care", "nursing interventions", "catheterization, peripheral", "peripheral inserted central catheter",

"PICC" and "complications" mediated by the Boolean operators AND for different descriptors and OR for similar descriptors. The strategy was adapted according to the particularities of each base (Chart 1).

Chart 1 - Search strategy

Source	Search strategy
Pubmed	(adult OR child) AND (nursing care OR nursing interventions) AND (catheterization, peripheral OR peripheral inserted central catheter OR PICC) AND (complications)
<i>Biblioteca Virtual em Saúde/ BVS/</i> Medline	(adult OR child) AND (nursing care OR nursing interventions) AND (catheterization, peripheral OR peripheral inserted central catheter OR PICC) AND (complications)
Cochrane	Catheterization, Peripheral OR Peripherally Inserted Central Catheter OR PICC AND nursing care AND nursing interventions
Cinahl	(adult OR child) AND (nursing care OR nursing interventions) AND (catheterization, peripheral OR peripheral inserted central catheter OR PICC) AND (complications)
Embase	(adult OR child) AND ((catheterization, AND peripheral OR peripheral) AND inserted AND central AND catheter OR PICC) AND complications AND (nursing AND care OR nursing) AND interventions

Source: Research data (2022).

It included studies carried out in humans (adults and children, regardless of gender), available in Portuguese, English, and Spanish, which included information regarding the outcome (complications and frequency), and the studied intervention (use of PICC), without time limitation, with punctures performed by nurses and/or physicians, regardless of the insertion technique. Secondary studies and an editorial, congress abstracts, two studies in animals, neonates, and oncologic patients were excluded since they present peculiarities for infectious and thrombotic complications, three studies that did not address the outcome of interest or the complications related to vascular devices other than the PICC, and four studies published in languages other than the Latin Roman alphabet.

The studies found were exported to the Endnote web® program, the duplicate references were excluded electronically and manually, and then these studies were directed to the Raayan QCRI® software for the first phase of the review. In this stage, the articles found in the search were submitted to peer-reading of the title and abstract (T.V.P and N.C.C.C.) independently, screening them for the subsequent phase. In the second phase, the studies submitted to exploratory reading and those that met the inclusion criteria were entered into the sample (T.V.P).

For data extraction and synthesis, a specific instrument was used, containing the following information: author(s), year of publication, place of study development, type of study, objective, sample characteristics, the professional who inserted the PICC, indication for the PICC use, incidence of complications, prevention/diagnosis care of the complication, and treatment, in addition to the average length of stay with the PICC. Data extraction was validated by the third reviewer (P.R.S.R). The studies were assessed and categorized according to the type of intervention proposed and the Level of Evidence (LE) (Chart 2).

Table 2 - LE classification ¹⁰

LE	TYPE OF STUDY
I	Systematic reviews or meta-analyses of relevant clinical trials.
II	Evidence from at least one well-designed randomized controlled trial.
III	Well-designed clinical trials without randomization.
IV	Well-designed cohort and case-control studies.
V	Systematic review of descriptive and qualitative studies.
VI	Evidence derived from a single descriptive or qualitative study.
VII	Authoritative opinion or expert committee report.

Source: Elaborated by the authors (2022).

The findings of this review were synthesized descriptively.

RESULTS

A total of 904 studies were retrieved in the search, after removing duplicates, 881 proceeded to screening. After reading the titles and abstracts, 17 were selected for exploratory reading, of these, seven were included in the review because they met the inclusion criteria (Figure 1).

From those included (n=7), English was the predominant language, present in 85.7% (n=6)^{11,12,13,14,15,16} of the studies, followed by Spanish in 14.3% (n=1)¹⁷. As for the countries where the study was conducted, 57.1% (n=4)^{13,14,15,16} in the United States, 14.3% (n=1)¹⁷ in Spain, 14.3% (n=1) in Canada¹¹ and 14.3% (n=1) in China.¹² As for the date of publication, they were published between the years 2002 and 2020.

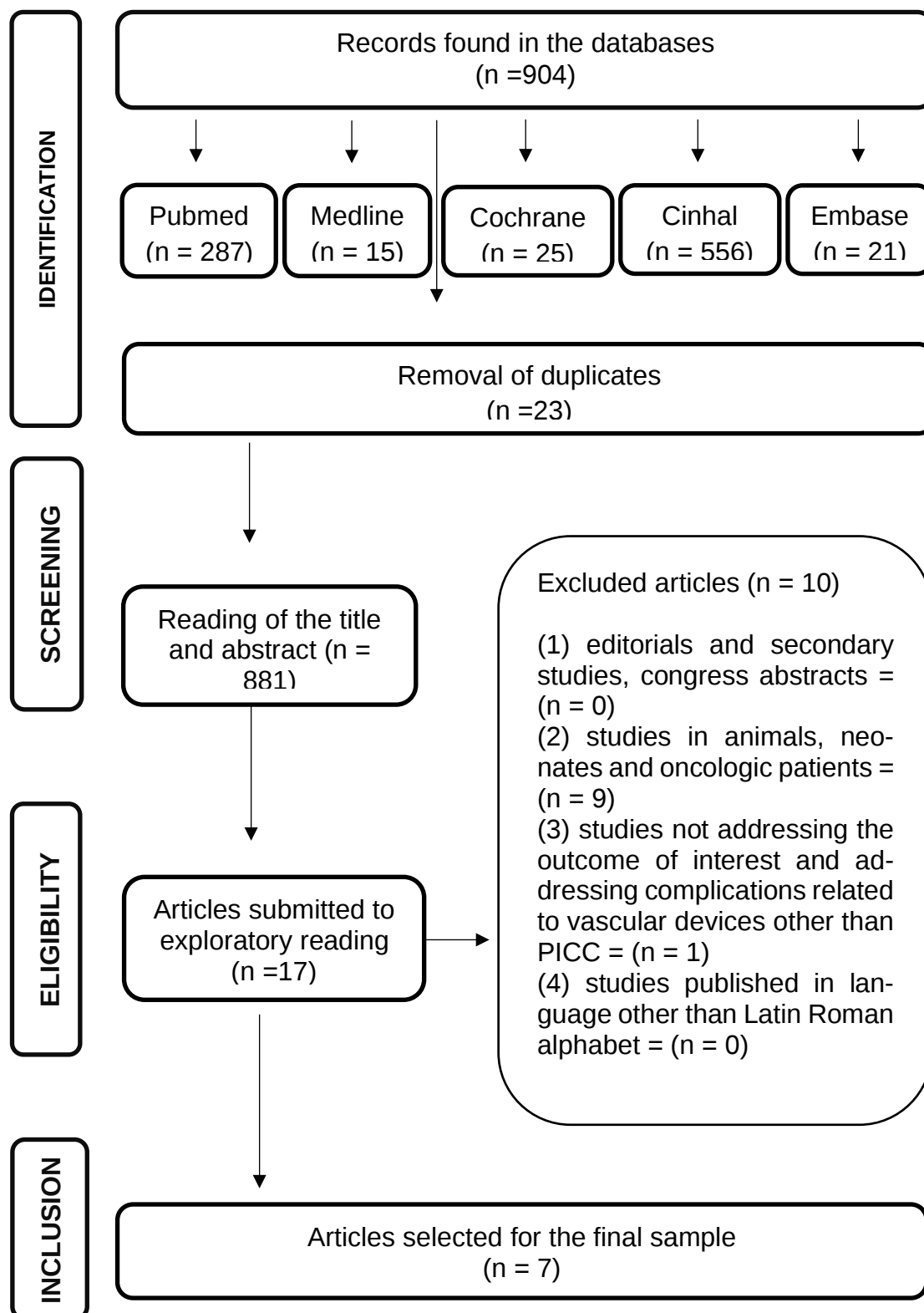


Figure 1 – Flow diagram according to the study selection criteria. Brasília (Distrito Federal), Brazil, 2021.

Source: Adapted figure from PRISMA flow diagram. Elaborated by the authors (2022).

As for the type of study, 71.4% (n=5)^{11,13,15,16,17} were observational (LE IV and VI) and 28.6% (n=2) were clinical trials (LE II),^{12,14} as described in table 2. Data extracted from the included studies are presented in tables 1 and 2.

Among the seven studies analyzed, 42.8% (n=3)^{15,16,17} had the PICC inserted only by nurses, in 28.6% (n=2)^{11,12} by nurses and physicians, in 14.3% (n=1)¹⁴ by nurses with the support of the Interventional Radiology Department, and in 14.3% (n=1)¹³ by a vascular access specialist, the profession of such specialist not being specified (Table 1).

The studies included in this review totaled 2,667 patients using the PICC, with the smallest sample of 33 patients¹⁶ and the largest with 2,063 patients.¹⁵ The mean age of patients in the studies ranged from 13.6 years to 66 years, in most studies the mean age was over 50 years.^{13,14,17} Males were predominant in 57.1% (4)^{11,13,14,17} of the studies, in others, these characteristics were not described,^{12,15,16} as shown in Table 1.

The main indications for the PICC insertion reported in this review were the need for venous access in 42.8% (three),^{13,14,17} the need for parenteral nutrition in 42.8% (three),^{11,14,17} the administration of vesicant and/or vasoactive drugs in 42.8% (three),^{11,14,17} the intravenous administration of antibiotics in 42.8% (three),^{11,14,15} of blood products in 14.3% (one),¹⁴ and hemodynamic monitoring in 57.1% (four),^{13,14,16,17} as shown in Table 1.

The average length of the PICC stay was not reported in three (42.8%) studies,^{12,13,15} and in the remaining studies, four (57.1%) showed a range of average PICC stay from 11.3 to 35.5 days.^{11,14,16,17}

Table 1 - Summary of the results included in this review (n=7)

Article Identification/ Country/ Year	Objective, type of study, LE	Sample size (n), mean age (years or median [min-max]), sex n (%)	Average length of stay (days)	Incidence of complications n (%)
Gamulka B, Mendoza C, Connolly B. ¹¹ Canada, 2005	Evaluate the safety and success of the PICCs*. Cohort IV	97, 13.6 years old [3-18], 52 (53.6%) boys, 37 (38.1%) hospitalized.	The PICCs* intended for PTN† had shorter mean length of stay (21.5 days PTN† vs. 39 days non-PTN†) (P 0.03).	28 (28.9%)
Geng Tian et al. ¹² China, 2011	To determine the feasibility and potential complications of the PICC insertion*. Clinical Trial III	225 PICCs* Sample characteristics not reported.	The study did not inform the length of stay.	41 (18.2%)
Smith RJ, et al. ¹³ USA, 2020	To determine the feasibility, safety, and duration of the PICC* insertion in critically ill patients. Retrospective cohort IV	55 obese and in shock in ICU\$ (> 18 years old); 66 [49.0-73.0]; mean BMI\$: 26.5; BMI\$ > 30: 17 (30.9%); 32 (58.2%) men.	The length of stay was not addressed in the article.	Three (5.45%) at the moment of insertion *

Trerotola SO, et al. ¹⁴ USA, 2010	To determine the outcomes associated with the use of Triple Lumen PICC* (TL‡) in an ICU§.	50 ICU§ (general, surgical and coronary), 51.6 [18-83] years old, 32 (68%) men.	The average length of catheter stay remained 17.1 days ± 12.6 (SD¶).	Four (8%) acute, 20 (40%) late
	Clinical Trial			
	Two arms: Triple Lumen (TL‡) PICCs* vs Triple Lumen (TL‡) Central Venous Catheters (CVCs).			
	II			
Lacostena-Pérez ME, Buesa-Escar AM, Gil-Alós AM. ¹⁷ Spain, 2018	To evaluate the rates and nature of complications related to PACVC*.	144 PACVC* (ICU§ or admission unit) 65.15 (SD¶: ± 14.58) years old, 61.8% (89) males	PICC* length of stay was 11.3 ± 19.8 days (SD¶)	71 (49.3%)
	Prospective observational study			
	IV			
Chemaly RF, et al. ¹⁵ USA, 2002	To assess the incidence of PICC-related upper extremity DVT‡* and associated risk factors	2.063 PICCs*	The length of stay of the PICC* is not addressed in the article.	104 (5.04%)
	Retrospective cohort			
	IV			

De Lemos C, Abi-Nader J, Akins PT. ¹⁶ USA, 2011	To evaluate peripherally inserted central catheters as an alternative to CVCs in neuro-critical care settings. Prospective descriptive study	33 (neurological intensive care)	The average length of stay of the PICC* was 19 days; range, 4-64 days.	One (3%)
IV				

*PICC - Peripherally Inserted Central Catheter; †CVP - Central Venous Pressure; ‡DVT - Deep Venous Thrombosis; §ICU - Intensive Care Unit; ||UL - Upper Limbs; ¶SD - Standard Deviation; *PACVC - Peripherally Accessed Central Venous Catheter; †PTN - Parenteral Nutrition; ‡TL - Triple Lumen; §BMI - Body Mass Index; ||CT - Chemotherapy, ¶IV - Intravenous.

Complications related to PICC use were categorized as local in six studies (85.7%),^{11,12,14,15,16,17} systemic in one study¹⁷, and circumstantial in five (71.4%) studies^{11,12,13,14,17} as shown in Table 2.

Table 2 - Complications related to PICC use

Local complications (n cases)	N of complications (%)
Phlebitis ^{11,17} (n=241)	20 (8.3)
Infection ^{12,17} (n=369)	16 (4.3)
Thrombosis ^{11,14,15,16} (n=2243)	64 (2.85)
Systemic complications	
Bacteremia ¹⁷ (n=144)	5 (3.5)
Circumstantial complications	
Occlusion ^{11,14} (n=147)	13 (8.8)
Malposition ^{11,12,13,14,17} (n=571)	55 (9.6)
Rupture ^{12,13,14} (n=241)	3 (1.2)
Accidental removal ¹⁷ (n=144)	7 (4.9)
Bleeding ¹⁷ (n=144)	1 (0.7)
Dermatitis ¹¹ (n=97)	3 (3.1)
External breakage ¹¹ (n=97)	3 (3.1)
Hematoma ¹³ (n=55)	1 (1.8)

Source: Research data (2022).

Regarding the care associated with complications resulting from the use of the PICC listed in this review, preventive care was identified in all studies,^{11,12,13,14,15,16,17} diagnostic care in four studies,^{12,14,15,17} and therapeutic care in two studies^{15,16}. Among the preventive care, care for malposition, thrombosis, infection, and occlusion were reported as shown in Table 3. For those of diagnosis, care for the identification of venous thrombosis and malpositioning is described according to Table 3. For treatment, care related to the treatment of venous thrombosis is presented as shown in Table 3.

Table 3 - Summary of the care listed in the included studies

Type of care	Complication	Care to be performed
Preventive	Thrombosis	Prophylactic use of anticoagulant. ^{13,16} Heparinization of the PICC with 150 units of heparin (100 U/ml solution) every 24 hours for those without a continuous infusion of IV solution. ¹¹ Use smaller-caliber, single-lumen catheters. ^{13,16} USG to select the best vein with the largest caliber ^{13,14} and prefer puncture in UL. ¹⁶
	Infection	Sterile technique for the PICC insertion (sterile mask, sterile cap, sterile glove, sterile field). ^{11,12,14,15,17} Limb washing with alcoholic chlorhexidine, ¹¹ aqueous chlorhexidine (2%), ¹⁷ 70% alcohol solution, and 2% chlorhexidine gluconate for insertion. ¹⁶ Hand hygiene and aseptic techniques for manipulation. ^{12,17} Protect the limb and/or insertion site with a sterile protector until positioning is verified (during transport for x-ray). ¹² Occlusion with a sterile adhesive dressing. ^{16,17}
	Malpositioning	Measure the insertion site to the sternal furcula or third intercostal space for PICC insertion. ¹² During PICC insertion, position the patient with the chin on the shoulder to prevent the catheter from going up the jugular vein. ¹¹ Use ECG during insertion to determine tip location through the P wave. ¹² USG to help identify the vein at the time of puncture and position the catheter appropriately. ^{11,16} Fixation of the catheter with nylon suture ¹⁴ or with the stabilizing device (Statlock) and the transparent dressing. ¹⁶
	Oclusion	Rinsing the catheter with saline solution after each use. ¹⁴
Diagnosis	Malpositioning	Chest X-ray immediately after catheter insertion, before guide-wire removal. ^{12,15}
	Thrombosis	USG and venography for the diagnosis of thrombosis. ^{14,15,17} Watch for signs of edema of the arm and/or neck and catheter malfunction. ¹⁴
Treatment	Thrombosis	Treatment with anticoagulant therapy (IV heparin followed by VO warfarin, warfarin alone or SC heparin) ^{16,15} , thrombolysis or thrombectomy. ¹⁵

DISCUSSION

This integrative review aimed to identify the complications related to the use of PICC, as well as the care to prevent and treat these complications. Among the seven studies included, the use of the PICC in children and adults was evaluated, as well as its complications and care related to.

The PICC is a medium to long-term-use catheter,^{18,19} widely utilized as an alternative to other CVCs,⁶ since it provides a safe central venous entry.¹⁸ Some studies corroborate the findings of this review^{3,4,6,18} and recommend the PICC mainly for patients who require intravenous therapy for more than six days, with reliable delivery of intravenous fluids, hemoderivatives, or hypertonic, sclerosing, and inflammatory solutions to the small veins, such as total parenteral nutrition, chemotherapy, antibiotics, and vasoactive drugs.^{3,4,6,18} The PICC has its length of stay variable depending on the need of each patient.²⁰

Despite having numerous benefits and indications compared to other central accesses, the use of PICC is also associated with complications, with phlebitis,^{11,17} infection,^{12,17} sepsis,¹⁷ thrombosis,^{11,14,15,16} occlusion,^{11,14} poor positioning,^{11,12,13,14,17} rupture,^{12,13,14} accidental removal,¹⁷ bleeding,¹⁷ hematoma¹³, and dermatitis¹¹ being the most common.^{11,12,13,14,15,16,17}

The incidence of infection is variable; some studies report,¹⁸ rates between 16.4% and 28.8%¹⁸ higher than those found in this review. Other authors²¹ have emphasized the importance of observing the appearance of local signs of infection, such as exudates, heat, hyperemia, and edema at the insertion site.²¹ In cases of fever ($> 38^{\circ}\text{C}$), chills, rigidity, and hypotension, a paired blood culture sample should be taken to identify the presence of bacteria or fungus in the catheter.²² In cases of positive blood culture, treatment with antibiotic therapy should be initiated.³ If the fever is not stopped within 48 hours and the blood culture remains positive, removal of the PICC is indicated.³

Infection prevention care includes the choice of PICCs with anti-infective technologies,¹ sterile technique for catheter insertion and maintenance, the use of 2% chlorhexidine for skin antisepsis, hand washing for catheter manipulation, the preferential use of sterile transparent film for dressing, the daily evaluation of the insertion site, the catheter, and the dressing in order to observe the signs of infection.¹⁸ Chlorhexidine 2% is the most efficient antiseptic when compared to povidone-iodine and alcohol, associated with lower rates (2%) of infection when compared to povidone-iodine (7.1%) and alcohol (9.3%).¹⁸

Thrombosis consists of thrombus formation inside the blood vessel due to venous stasis, endothelial injury, and hypercoagulability.⁶ It is the second major complication related to the use of PICC, with a prevalence of 13% to 91%.¹⁸ Endothelial trauma and inflammation of the vascular wall result from both insertion and maintenance of long-term intravenous catheters.⁶ The findings of this review corroborate the critical and obese patients, as they have a high risk of thrombosis, as well as oncologic patients, with hereditary thrombophilias and with chronic obstructive pulmonary disease.²³

To avoid the risks of thrombosis, the use of USG is suggested, measuring the diameter of the vein before insertion.²⁴ In this way, it is possible to adapt the caliber of the catheter to the

ideal diameter for the patient, less than one-third of the diameter of the blood vessel,²⁵ the use of USG to guide the passage of the PICC decreasing the risk of an endothelial lesion by multiple attempts, and to prefer single lumen catheters, unless multi-lumen catheters are needed.²⁴

The existing guidelines²⁶ do not recommend routine pharmacological prophylaxis for thrombosis prevention. The treatment of PICC-related thrombosis has guidelines on the use of low molecular weight heparin,²⁷ being the recommended dose of 7.5mg for individuals with body weight between 50 and 100kg,²⁸ not requiring catheter removal, unless there is persistence or worsening of thrombotic symptoms.²⁷

Another complication is obstruction of the PICC, which may have a thrombotic or non-thrombotic cause, being partial or total, limiting or preventing the administration of drugs or blood collection through the device.²⁷ The causes of non-thrombotic obstruction occur due to the presence of mineral, lipid, and drug precipitates, bending of the catheter, very tight sutures, or the catheter's poor positioning. Thrombotic obstructions are caused by fibrin deposition inside or around the catheter tip.²⁹

One study reported that occlusion of the catheter occurred in 4% of the cases,²⁷ in another study the rate was 8.9%,¹⁹ similar to the occlusion rate found in this review. For the maintenance of catheter permeability and prevention of obstruction, it is recommended to wash the catheter with 0.9% saline solution by pulse flush, with a 10ml syringe or larger volume, after medication infusion or at six-hour intervals.³⁰ The use of mono-lumen PICCs is suggested,²⁴ since catheters with more lumens are more likely to obstruct due to the reduced caliber of the lumens.²⁴

In the occurrence of obstruction, treatment with thrombolytic drugs is recommended,^{29,25} such as alteplase (2 mg / 2 ml) and urokinase (5000 IU/ml) corresponding to the volume of the catheter, and should perform for 30 minutes.^{25,29} Although alteplase is described as a safe and effective drug for catheter unblocking, its disadvantage is its high cost.³ Vitamin C has been studied as a possible alternative due to its potential action on *von Willebrand* factor (vWF); tissue plasminogen activator (t-PA); plasminogen activator inhibitor type I (PAI-1), and platelet aggregation, at a more affordable cost. This has already been used empirically by nurses for PICC clearance.³¹

The final location of the PICC tip should be located in the distal third of the superior vena cava.³ Poor positioning may be caused by the different venous anatomy, inadequate positioning of the patient at the time of insertion, incorrect measurement of the catheter, and even accidental traction of the catheter.³ Corroborating the findings of this review, the data pointed out that chest radiography is the gold standard for the location of the catheter tip.³² It is important to emphasize that new technologies have been widely used in this context, such as the use of an Electrocardiogram (ECG) during catheter insertion, through the P-wave peak amplitude.³²

In cases of malpositioning, traction maneuvers are recommended for repositioning³ whenever possible; to avoid accidental traction of the catheter, the use of the SecurAcath device is recommended, which attaches the device to the patient's subcutaneous tissue, without the need for suture¹⁸ or the use of the Statlock®³ device, later occluded with the transparent film.^{3,18}

Phlebitis occurs due to an inflammatory response at the insertion site and may extend throughout the involved vein, having a mechanical or infectious cause.²⁰ Catheter rupture is a

rare complication associated with improper handling of the device,³⁰ occurring mainly due to excessive flush pressure.¹⁸ Accidental removal of the PICC occurs due to lack of skill in dressing changes, or accidental traction of the infusion system.³³ Dressing-related skin reactions are common,¹⁸ and occur due to reaction to the medical adhesive, manifested by erythema, blistering, or erosion.²²

The PICC has several advantages compared to the traditional CVC, such as decreased risks of pneumothorax,²² lower risks of infectious complications due to the catheter's insertion location,^{3,22} low cost, and stable, long-term venous access.²²

Although the PICC has low complication rates compared to other devices, it is necessary to understand evidence-based practices on insertion technique, early detection of complications, and PICC care to prevent complications. The implementation of ongoing education and training on PICC care for the nursing staff is of paramount importance to prevent and reduce complications. Further studies on the subject become necessary to demonstrate the best therapeutic evidence for each complication, in addition to conducting studies in other populations.

Limitations of the study

Among the limitations found, the scarcity of studies addressing populations other than oncology patients and neonates is cited. Another limiting factor was the lack of coverage of all complications related to the use of the PICC, or at least most of them, in addition to the absence of studies that had as their object the care related to the use of the PICC, whether preventive or therapeutic, especially Nursing care.

CONCLUSION

Based on this review, it was possible to identify a low incidence of complications related to the use of PICC. Phlebitis, infection, bacteremia, thrombosis, occlusion, malposition, rupture, accidental removal, bleeding, hematoma, and dermatitis are the most common type.

The care related to the PICC evidenced in this review was for thrombosis, infection, poor positioning, and occlusion. However, it becomes necessary to increase the number of studies on the subject, considering that the Nursing team deals daily and directly with the catheter, being the main source for the prevention, diagnosis, and treatment of complications.

The occurrence of complications causes negative impacts to care. Complications such as infection, thrombosis, and PICC obstruction increase treatment time, medical costs, patient morbidity, and mortality. Thus, it is important to establish a care plan to prevent and identify them early and to treat them according to the best evidence found.

CONTRIBUTIONS

Author 1) (a) conception or design of the study/research, (b) analysis and/or interpretation of the data, (c) final review with critical and intellectual participation in the manuscript; Author 2) (b) analysis and/or interpretation of the data; Author 3) (b) analysis and/or interpretation of the data, (c) final review with critical and intellectual participation in the manuscript; Author 4) (a) conception or design of the study/research, (b) analysis and/or interpretation of the data, (c) final review with critical and intellectual participation in the manuscript.

CONFLICT OF INTERESTS

Nothing to declare.

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REFERENCES

- 1 Ullman AJ, August D, Kleidon T, Walker R, Marsh NM, Bulmer A, et al. Peripherally inserted central catheter innovation to reduce infections and clots (the PICNIC trial): a randomised controlled trial protocol. *BMJ Open*. 2021; 11 (4):e042475. DOI: 10.1136/bmjopen-2020-042475.
- 2 Mena LS, Silva RC, Porto AR, Zillmer JGV, Barcellos CRB. Cateter venoso central de inserção periférica em neonatologia: potencialidades e fragilidades na ótica de enfermeiros. *Cienc Cuid Saude*. 2019; 18 (4) e47495. DOI:10.4025/cienccuidsaude.v18i4.47495
- 3 Di Santo MK, Takemoto D, Nascimento RG, Nascimento AM, Siqueira E, Duarte CT, et al. Cateteres venosos centrais de inserção periférica: alternativa ou primeira escolha em acesso vascular? *J Vasc Bras*. 2017; 16 (2):104-112. DOI:10.1590/1677-5449.011516
- 4 Simonetti G, Sommariva A, Lusignani M, Anghileri E, Ricci CB, Eoli M, et al. Prospective observational study on the complications and tolerability of a peripherally inserted central catheter (PICC) in neuro-oncological patients. *Support Care Cancer*. 2020; 28 (6):2789-2795. DOI: 10.1007/s00520-019-05128-x.
- 5 Vera SO, Sousa GN, Araújo SNM. The work of nurses in the practice of inserting and maintaining the PICC: a literature integrative review. *Portuguese ReOnFacema*. 2015; 1 (1):47-53. Available from: <https://www.facema.edu.br/ojs/index.php/ReOnFacema/article/view/9/12>. Acesso em 08 out 2021.
- 6 Barbosa JAS, Silva TCC, Pardo DM, Garcia MR, Poltronieri MJA. Cateter venoso central de inserção periférica e trombose: experiência em hospital de alta complexidade. *Cogitare enferm*. 2020; 25: e70135. DOI: 10.5380/ce.v25i0.70135.
- 7 Barbosa CV, Canhestro MR, Couto BRGM, Guimarães GL, Mendoza IYQ, Goveia VR. Saberes da equipe de enfermagem sobre cuidados com cateter venoso central. *Rev enferm UFPE on line*. 2017; 11 (11):4343-50. DOI:10.5205/reuol.23542-49901-1-ED.1111201710.
- 8 Gonçalves KPO, Sabino KN, Azevedo RVM, Canhestro MR. Avaliação dos cuidados de manutenção de cateteres venosos periféricos por meio de indicadores. *REME – Rev Min Enferm*. 2019; 23: e-1251. DOI: 10.5935/1415-2762.20190099.
- 9 Mendes KS, Silveira RCCP, Galvão CM. Revisão integrativa: método de pesquisa para a incorporação de evidências na saúde e na enfermagem. *Texto & Contexto - Enfermagem* 2008;17(4):758-64. DOI: 10.1590/S0104-07072008000400018.
- 10 Melnyk BM, Fineout-Overholt E. Evidence based practice in nursing and healthcare. 3 ed. Philadelphia: Wolters Kluwer/ Lippincott Williams & Wilkins, 2014. 10-11.
- 11 Gamulka B, Mendoza C, Connolly B. Evaluation of a unique, nurse-inserted, peripherally inserted central catheter program. *Pediatrics*. 2005; 115(6):1602-6. DOI: 10.1542/peds.2004-0542.
- 12 Geng Tian, Bin Chen, Li Qi, Yan Zhu. Modified insertion of a peripherally inserted central catheter: taking the chest radiograph earlier. *Crit Care Nurse*. 2011; 31 (2):64-9. DOI: 10.4037/ccn2011966.
- 13 Smith RJ, Cartin-Ceba R, Colquist JA, Muir AM, Moorhead JM, Callisen HE, et al. Peripherally inserted central catheter placement in a multidisciplinary intensive care unit: A preliminary study demonstrating safety and procedural time in critically ill subjects. *J Vasc Access*. 2020; 22 (1):101-106. DOI: 10.1177/1129729820928618.

- 14 Trerotola SO, Stavropoulos SW, Mondschein JI, Patel AA, Fishman N, Fuchs B, et al. Triple-lumen peripherally inserted central catheter in patients in the critical care unit: prospective evaluation. *Radiology*. 2010; 256 (1):312-20. DOI: 10.1148/radiol.10091860.
- 15 Chemaly RF, de Parres JB, Rehm SJ, Adal KA, Lisgaris MV, Katz-Scott DS, et al. Venous thrombosis associated with peripherally inserted central catheters: a retrospective analysis of the Cleveland Clinic experience. *Clin Infect Dis*. 2002; 34 (9):1179-83. DOI: 10.1086/339808.
- 16 DeLemos C, Abi-Nader J, Akins PT. Use of peripherally inserted central catheters as an alternative to central catheters in neurocritical care units. *Crit Care Nurse*. 2011; 31 (2):70-5. DOI: 10.4037/ccn2011911.
- 17 Lacostena-Pérez ME, Buesa-Escar AM, Gil-Alós AM. Complicaciones relacionadas con la inserción y el mantenimiento del catéter venoso central de acceso periférico. *Enferm Intensiva*. 2019; 30 (3):116-126. DOI:10.1016/j.enfi.2018.05.002
- 18 Duwadi S, Zhao Q, Budal Bs. Peripherally inserted central catheters in critically ill patients - complications and its prevention: A review. *Int J Nurs Sci*. 2018; 6(1):99-105. DOI: 10.1016/j.ijnss.2018.12.007.
- 19 Grau D, Clarivet B, Lotthé A, Bommart S, Parer S. Complications with peripherally inserted central catheters (PICCs) used in hospitalized patients and outpatients: a prospective cohort study. *Antimicrob Resist Infect Control*. 2017; 6:18. DOI:10.1186/s13756-016-0161-0
- 20 Hertzog DR, Waybill PN. Complications and controversies associated with peripherally inserted central catheters. *J Infus Nurs*. 2008; 31 (3):159-63. DOI:10.1097/01.NAN.0000317702.66395.f1.
- 21 Freitas JS, Vador RMF, Cunha FV, Silva AA. Manuseio do cateter central de inserção periférica (PICC) pelo enfermeiro em pediatria. *Brazilian Journal of Health Review*. 2020; 3 (6): 16891-16910. DOI:10.34119/bjhrv3n6-119
- 22 Zhang S, Sun X, Lei Y. The microbiological characteristics and risk factors for PICC-related bloodstream infections in intensive care unit. *Scientific Reports*. 2017; 7 (1):15074. DOI:10.1038/s41598-017-10037-2
- 23 Fallouh N, Mcguirk HM, Flanders SA, Chopra V. Peripherally Inserted Central Catheter-associated Deep Vein Thrombosis: A Narrative Review. *Am J Med*. 2015; 128 (7):722-38. DOI: 10.1016/j.amjmed.2015.01.027.
- 24 Walters B, Price C. Quality Improvement Initiative Reduces the Occurrence of Complications in Peripherally Inserted Central Catheters. *J Infus Nurs*. 2019; 42(1):29-36. DOI: 10.1097/NAN.0000000000000310.
- 25 Lomba L, Gomes AC, Bogalho C, Jesus I, Sousa AF. Prevenção de complicações em cateteres centrais de inserção periférica: revisão integrativa da literatura. *Rev. iberoam. Educ. investi. Enferm*. 2020; 10 (2):47-58. Disponível em: <https://www.enfermeria21.com/revistas/aladefe/articulo/329/prevencao-de-complicacoes-em-cateteres-centrais-de-insercao-periferica-revisao-integrativa-da-literatura/>. Acesso em 08 out 2021.
- 26 Kearon C, Akl EA, Comerota AJ, Prandoni P, Bounameaux H, Goldhaber SZ, et al. Antithrombotic therapy for VTE disease: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest*. 2012; 141 (2 Suppl):e419S-e496S. DOI: 10.1378/chest.11-2301. Erratum in: *Chest*. 2012 Dec;142(6):1698-1704.
- 27 Bertoglio S, Faccini B, Lalli L, Cafiero F, Bruzzi P. Peripherally inserted central catheters (PICCs) in cancer patients under chemotherapy: A prospective study on the incidence of complications and overall failures. *J Surg Oncol*. 2016; 113(6): 708–714. DOI:10.1002/jso.24220
- 28 Burihan MC, Campos Junior W. Consenso e atualização na profilaxia e no tratamento do tromboembolismo venoso. 1. ed. Rio de Janeiro : Guanabara Koogan, 2019. Available from: <https://sbacv.org.br/wp-content/uploads/2021/03/consenso-e-atualizacao-no-tratamento-do-tev.pdf>. Acesso em: 23 abril 2022.

29 Byrne D, Penwarden L. Selection of Single- Versus Double-Lumen Peripherally Inserted Central Catheters and the Influence on Alteplase Use. J Infus Nurs. 2018; 41 (2):118-121. DOI:10.1097/NAN.0000000000000269.

30 Cavalcante RC, Marques ADB, Branco JGO, Couto CS, Campos ACS, Rolim KMC. Cuidados de enfermagem na manutenção do cateter central de inserção periférica em neonatos: revisão integrativa. Revista Prevenção de Infecção e Saúde. 2015; 1(2):64-74. DOI:10.26694/repis.v1i2.3591

31 Macedo AA, Oliveira BGRB, Kang HC, Carvalho MR. A ação da vitamina C no processo de coagulação: um estudo experimental in vitro. Online Brazilian Journal of Nursing (Online) 2010; 9(1). Disponível em: <http://www.objnursing.uff.br/index.php/nursing/article/view/j.1676-4285.2010.2670/590>. Acesso em: 08 out 2021.

32 Gao Y, Liu Y, Zhang H, Fang F, Song L. The safety and accuracy of ECG-guided PICC tip position verification applied in patients with atrial fibrillation. Ther Clin Risk Manag. 2018; 14:1075-1081. DOI: 10.2147/TCRM.S156468.

33 Camara SMC, Tavares TJL, Chaves EMC. Cateter venoso de inserção periférica: análise do uso em recém nascidos de uma unidade neonatal pública em fortaleza. Rev. RENE. 2007; 8 (1): 32-37. Disponível em <http://periodicos.ufc.br/rene/article/view/5266/3880>

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