International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-10; Oct, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.910.41

# Associated factors and complications resulting from the use of a Peripherally Inserted Central Catheter in neonates

Daniel Lucas Costa Monteiro[1], Marivaldo de Moraes e Silva[2], Victoria Moraes Perinazzo[3], Maria Caroline do Vale Souza[4], Thaiz Taiana Cardoso de Barauna[5], Francisco Miguel da Silva Freitas[6], Adrianne Raposo Ponte[7], Iasmim Rodrigues Salvador[8], José Lucas Borges Blans[9], Thais do Socorro Botelho Lima e Silva[10], Luana Fernandes Coelho[11], Yasaman Kós Miranda[12], Leila Assef Mendes[13], Lorena Machado Freire de Carvalho[14], Luca Thomas Lins Dalferth[15], Camylla Rebbeca Bezerra de Aragão[16], Fabiane da Costa Figueiredo[17], Antônio Aécio de Miranda Lima Junior[18], Vanessa Marques da Silva Creão[19], Victor Basileu Farrel Ferreira Neves[20], Lara Rosa Cardoso e Cardoso[21], Pedro Thiago Malcher de Amorim Dias[22], Breno Brito Barbosa[23], Maria Luiza Goes Pimentel[24], Manuela de Almeida Paiva[25], Roberta Macias dos Santos[26], Suyanne Lobato Rodrigues[27], Caroline do Mont Figueiredo[28], Hilane dos Santos Alves[29], Aline França Nunes[30], Camila Milene Barros Brito[31], José Wilker Gomes de Castro Júnior[32], Ticiane dos Santos Foss[33], Nathalia Moura Soares[34], Lara de Melo Siems[35], Adrielly Cristiny Mendonça Fonseca[36]

[1]Academic of Medicine. Metropolitan University Center of the Amazon (UNIFAMAZ), Belém, Pará, Brazil.
[2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28]Academic of Medicine. Metropolitan University Center of the Amazon (UNIFAMAZ), Belém, Pará, Brazil.
[29,30,31,32,33,34]Academic of Medicine. University Center of Para (CESUPA). Belem, Para, Brazil.
[35]Doctor, University Center of Para (CESUPA). Belem, Para, Brazil.
[36]Nurse. Metropolitan University Center of the Amazon (UNIFAMAZ), Belém, Pará, Brazil.

Received: 25 Sep 2022,
Received in revised form: 16 Oct 2022,
Accepted: 21 Oct 2022,
Available online: 28 Oct 2022



***Keywords*— Peripherally Inserted Central Catheter, PICC insertion, Complications, Newborn.**

***Abstract*—** *Peripherally Inserted Central Catheters (PICC) consist of an intravenous device widely used in neonates in intensive care units, characterizing a procedure that is related to a long repertoire of complications that can intensify neonatal morbidity and mortality. The study aims to review and analyze the factors associated with complications resulting from the use of peripherally inserted central catheter in neonates. Method: This is a bibliographic, descriptive analysis, of the integrative literature review type, with searches carried out in the Scientific Electronic Library Online (SciELO) and PubMed databases. Eight complete articles were selected, available in open access in Portuguese and English and published in the years 2018 to 2022. Results: From the analysis of the classes, three categories emerged: Class 1- Risk Factors Associated with PICC Use, Class 2 - Complications*

*Deriving from the use of the PICC, Class 3 - Professional Training against the Maintenance of the PICC. Conclusion: it was evidenced that care related to the insertion and maintenance of the PICC is mainly directed to the control of nosocomial infection, highlighting the adherence to aseptic techniques for handling the catheter, performing the dressing and proper hand hygiene.*

## I. INTRODUCTION

Peripherally Inserted Central Catheters (PICC) are frequently used in neonatal intensive care units (NICU) in term and preterm newborns (NBs), usually when NBs require venous access for a prolonged period, offering hydration, parenteral nutrition, vesicant or irritating medications, in high concentrations (Silva, IMF, et al, 2021).

The PICC consists of a long central intravenous device with peripheral insertion, biocompatible and biostable, widely used in neonates in intensive care units requiring complex invasive procedures (Oliveira, CR, et al, 2014).

It consists of a single or double lumen composed of polyurethane or silicone (silicone are more flexible and imply less irritation to the vessel walls), which is inserted in the course of a superficial vein located at the ends of the body, which with the help of a needle, moves to the distal middle third of the superior or inferior vena cava, achieving characteristics of a central venous catheter (Beiral, FMF, 2015).

The use of the PICC in neonatology enables effective, safe, prolonged and comfortable intravascular venous access to a fragile community vulnerable to iatrogenic risks. Its insertion and handling require health professionals with technical and legal competence for its execution(Oliveira, CR, et al, 2014).

Among the advantages associated with the use of the PICC as a care instrument for neonates in a NICU, the following stand out: the reduction of repeated venipunctures, the easy central venous access with the opportunity of implantation at the bedside, the reduction of the risk of complications associated with insertion, when compared to other central venous accesses and, consequently, in the reduction of pain and suffering (Mittang, BT, et al, 2020).

However, the implantation and maintenance of the PICC are complex procedures and its use is related to a long repertoire of complications that can intensify neonatal morbidity and mortality. For this reason, there are potential complications such as bloodstream infection, catheter rupture, catheter tip migration, obstruction and leakage of medications (Mittang, BT, et al, 2020).

Silva, IMF, et al, (2021) explain that these disadvantages occur less frequently than other centrally located catheters, however, they require special attention from the professionals responsible for the indication of use. Thus, knowing that NICU NBs are unstable and many of the complications can be avoided, it is essential that health professionals promote the prevention of potential complications inherent to the implementation and maintenance of the PICC.

In this context, the study aims to review and analyze, through the literature, the factors associated with complications resulting from the use of peripherally inserted central catheter in neonates, as well as recommendations to prevent them.

## II. METHOD

This is a bibliographic, descriptive analysis of the integrative literature review type, which allowed analyzing and interpreting a theme distinct from other independent researches. It is noted that the execution of the study was carried out in five main stages: identification of the guiding question of the research; literature search; definition of inclusion and exclusion criteria; data evaluation; interpretation and discussion of results and display of the review.

Thus, the study presents the following guiding question: What factors are associated with complications resulting from the use of peripherally inserted central catheter in neonates?

To carry out the research, the Scientific Electronic Library Online (SciELO) and PubMed databases were consulted. For the search, the descriptors in Health Sciences (DeCS) were used, namely, “Peripherally Inserted Central Catheter” and “Newborn”, using the Boolean operator “AND” to verify the associations of the descriptors with each other.

The search was carried out during the month of September 2022. For the selection of material, the following inclusion criteria were considered: complete articles; available in open access in Portuguese and English; in the last five years, published in the period from 2018 to 2022.

Initially, 552 publications were found, however, after applying the inclusion criteria, this number was reduced to 77 studies. Thirty-five articles were found in SciELO and 42 in PubMed, with only four duplicate articles in SciELO and two in PubMed. Thus, 46 articles were selected from the reading of the titles and 12 articles by the abstract, leaving 8 studies chosen for reading in full, 5 from PubMed and 3 from SciELO. 475 journals were excluded for not being complete or for not answering the research question. Figure 1 shows the flowchart of the article selection process.

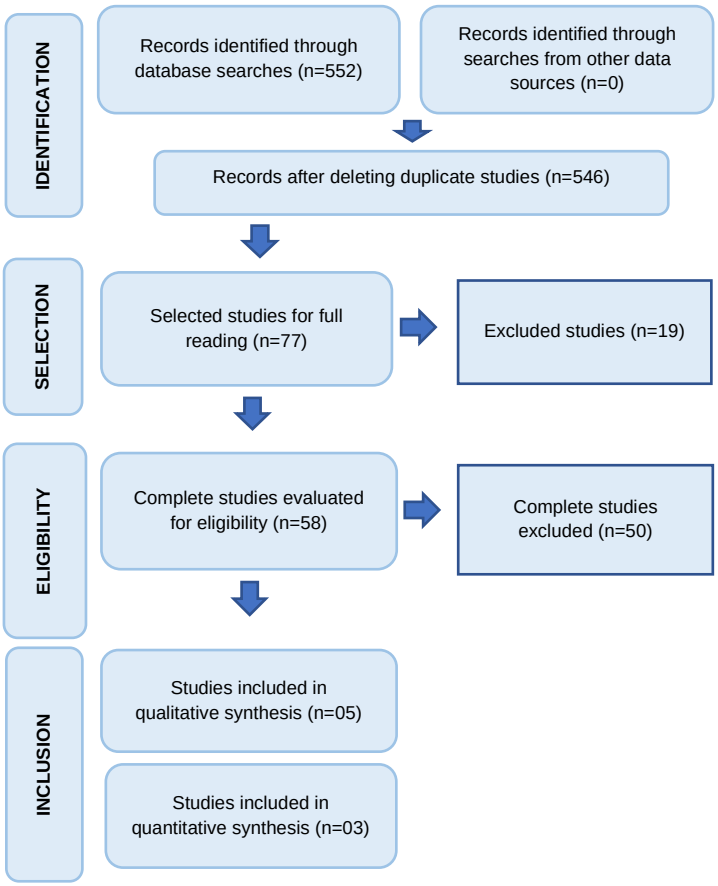


*Fig.1: Flowchart of the article selection process.*

**Source:** Study selection flowchart adapted of Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA 2009). Belém (PA), Brasil, 2022.

From the pre-reading of each article selected in the research, it was possible to analyze and characterize them in terms of authorship, year of publication, title, virtual libraries, method and levels of evidence.

Estimated studies of high quality of evidence: level 1 - meta-analysis of multiple controlled studies; level 2 - individual studies with experimental design, moderate quality of evidence (study with quasi-experimental design as a study without randomization with a single group before and after the test, time series or case control; level 3 - studies of non-experimental designs, such as descriptive correlation and qualitative studies or case studies; level 4 - case reports or systematically obtained data; level 5 - weak evidence (opinion of reputable authorities based on clinical competence or expert committee opinion, including non-evidence-based interpretations of information - level 6) (Duncombe, DC , 2018).

The textual corpus was developed with the conclusions of the studies, organized into a single text file for Bardin's treatment and analysis. According to Bardin (2016), this method is divided into three stages: organization of analysis, coding and categorization. Thus, the organization of the analysis is characterized by the exhaustive reading and interpretation of the results obtained; in coding, the units of records in the transcribed material will be classified and in categorization, the observed results are listed in categories.

In this sense, after the step described, the studies were analyzed through a critical reading of the defined articles, in order to extract information on factors associated with complications resulting from the use of peripherally inserted central catheter in neonates, according to the content of the literature.

## III. RESULTS AND DISCUSSION

After selection, only 08 articles met the criteria established in this review, one in 2022 (12.5%), four in 2021 (50%), one in 2019 (12.5%) and two in 2018 (25%). It was noted that five journals are in the PubMed virtual library (62.5%) and three in SciELO (37.5%).

Regarding languages, four studies were recorded in English (50%) and four in Portuguese (50%). Regarding the methodology used, five studies were classified as qualitative (62.5%) and three as quantitative (37.5%). Therefore, the articles included in this review are presented, thus exposing the specifications regarding the code of each article, author, year, title, virtual library, method and levels of evidence (Table 1).

*Table 1: Integrative review articles.*

| Author / Year | | Title | Virtual Library | Method | Evidence Level |
|---|---|---|---|---|---|
| **A1** | BELEZA, Ludmylla Oliveira, et al. 2021. | Update of practice recommendations regarding central catheter insertion peripheral in newborns. | SCIELO | Qualitative Study, of systematic review. | Level 4 |
| **A2** | BAHOUSH, Gholamreza, et al. 2021. | A review of peripherally inserted central catheters and various types of vascular access in very small children and pediatric patients and their potential complications. | PUBMED | Quantitative Study, of the cohort type. | Level 2 |
| **A3** | DINIZ, Edienne Rosângela Sarmento, et al. 2021. | Prevalence of complications associated with the use of a peripherally inserted central catheter in newborns: A systematic review protocol. | PUBMED | Meta-analysis. | Level 1 |
| **A4** | CAVALCANTE, Joyce Silva; LIMA, Évily Caetano. 2018. | Complications arising from the use of the central catheter peripheral insertion in neonates and associated factors. | PUBMED | Qualitative Study, of descriptive and exploratory. | Level 3 |
| **A5** | GOMES, Thainá Castro, et al. 2019. | Nursing care in prevention of PICC-related infections in neonatal unit. | SCIELO | Qualitative Study, review type integrative. | Level 3 |
| **A6** | LUI, Andressa Marcelly Lourenço, et al. 2018. | Care and limitations in the management of the peripherally inserted central catheter in neonatology. | SCIELO | Qualitative Study, review type integrative. | Level 3 |
| **A7** | CHANG, Li-Xian, et al. 2021. | Analysis of peripherally inserted central catheter-related complications: a retrospective cohort study of 2,974 children with blood diseases in a single center of China. | PUBMED | Quantitative Study, analytical and Retrospective cohort type. | Level 2 |
| **A8** | KOCHANOWICZ, Julian, et al. 2022. | Catheter-related bloodstream infections in infants hospitalized in neonatal intensive care units: a single center study. | PUBMED | Quantitative Analytical Cross-sectional Study, case-control type. | Level 2 |

**Source:** Own authorship. Belém (PA), Brasil, 2022.

From the analysis of the classes, three categories emerged: Class 1 - Risk factors associated with PICC use, Class 2 - Complications deriving from the use of the PICC, Class 3 - Professional training against the maintenance of the PICC.

**Class 1 – Risk factors associated with PICC use.**

According to study A2, it was found that 69% of the NBs who used the PICC were premature. Prematurity is identified as one of the main reasons for hospitalization in neonatal units, and also the main responsible for high rates of morbidity and mortality that affect the neonatal period. Borghesan, NBA (2015) highlights that this is one of the main recommendations for the use of the PICC, since the premature NB sometimes needs prolonged periods of hospitalization that demand intravenous therapy.

In study A4, it was identified that gestational age is directly associated with sensitivity variation of tissue maturity, with premature newborns being more subject to changes in tissue immaturity due to fragility and risk of infection. Silva, IMF, et al (2021) certifies that infant maturity is the single most significant factor to assess the risk of a newborn suffering complications and that gestational age is, in addition to birth weight, the parameter most frequently used to establish an unfavorable outcome.

In addition to the risk factors, the type and material of the catheter, the place of choice for implantation and the non-development of the technique recommended in the insertion and handling of the catheter (A2). Gonçalves, J (2017) observed that some conditions significantly increase the susceptibility to infections, such as: catheter use time, parenteral nutrition infusion, blood transfusion, multiple invasive procedures and inadequate aseptic techniques also predispose newborns to nosocomial infections, the most frequent being blood infection linked to the use of catheter.

In study A4, it was noted that catheters used for parenteral nutrition administration are subject to contamination by microorganisms due to the elements facilitating growth in the infusate. For this reason, Borghesan, NBA (2015) points out that bloodstream infection associated with the use of PICC is a risk to the admission of any vascular access device and that proper handling of the solution and short infusion intervals are of great relevance in daily catheter care.

**Class 2 – Complications deriving from the use of the PICC.**

According to Mittang, BT, et al (2020) national studies show that complications occurred in 41% to 50.8% of PICCs. However, international studies reveal a lower incidence of complications, between 2.9% and 31.7%. Thus, study A3 highlights that the potential complications inherent to PICC implantation are phlebitis, infection, thrombosis, catheter migration, catheter fracture with potential for embolism, occlusion and rupture, which can be classified as local, systemic or circumstantial complications.

Mechanical, infectious or thrombotic complications limit the usefulness of this device and may lead to its removal earlier than scheduled, that is, not effectively (A4). Santolim, TQ (2017) stresses phlebitis as a multifactorial condition, consisting of inflammation of the endothelial cells of the vein, which can be of mechanical, chemical or bacterial origin, that is, it can be avoided. Thus, it presents signs and symptoms such as: erythema, edema, pain, vein hardening and drainage by insertion.

Mechanical phlebitis is the most common in the PICC and may result from inadequate insertion technique, conditions inherent to the patient and the vein characteristics. Chemical phlebitis is caused by irritating medications, inadequate dilution of the solution and rapid infusion. And infectious phlebitis is inflammation of the venous wall, due to invasion by microorganisms resulting from failure in aseptic technique during the catheter implantation and maintenance procedure (A6).

Renfeng, L, et al (2019) shows that the prevention of traction and phlebitis can have a significantly positive impact on reducing catheter-related complications, preventing its early withdrawal. Study A7 observed that for safe implantation of the PICC, the caliber must be determined by the professional, considering the adjustment of the lumen diameter for the weight and age of the NB, being suitable those that respect the size of the vessel.

PICC infection, whose incidence varies between 5 and 25%, may be associated with microbial contamination of the infusion or catheter, being the most common source of local infections. If the neonate has fever, tachypnea, tachycardia, hypotension, expiratory grunting, cyanosis, among others, for no known reason, catheter-related sepsis should be investigated (Mittang, BT, et al, 2020).

When infectious complications occur, the infusion must be suspended and restarted in another limb, in addition to correctly performing the treatment with antibiotics according to the doctor's prescription, monitoring vital signs and conducting the culture of the

device in the ostium of the insertion (Rangel, RJM, et al, 2019).

According to study A8, regarding the prevention of infection, the cautious use of chlorhexidine during skin asepsis is recommended in low birth weight newborns in the first 14 days of existence due to chemical burns, as well as in infants under 2 months because there are records of systemic absorption.

For A6, inadequate handling of the PICC can cause another complication, which is catheter occlusion. This complication is related to few catheter washes before and after drug infusion, between drug infusion and after blood collection. Washes with 0.9% saline are essential to preserve catheter patency.

It is observed that PICC obstruction may result from thrombotic or non-thrombotic occlusion, partial or total of the catheter lumen, which limits or prevents the administration of solutions or the aspiration of blood through the device, compromising the safety of the NB by causing delay or interruption of therapy (A7). Santolim, TQ (2017) identifies that for the prevention of thrombotic and non-thrombotic obstructions and maintenance of permeability, it is suggested to perform a flushing with 0.9% saline solution every 6-8 hours, to permeabilize the interior of the catheter, ruling out adversities such as incompatibility between the infused drugs, preventing the development of thrombi and their obstruction.

Study A3 draws attention to device traction, which can happen accidentally during dressing change, causing the catheter tip to migrate to another location, staying in a peripheral position and, consequently, influencing drug therapy. Rangel, RJM, et al (2019) highlights that catheters located inadvertently in the heart can cause erosion, perforation, tamponade or cardiac abscess.

For this reason, Renfeng, L, et al (2019) emphasize that confirmation of the positioning of the catheter tip is essential, and its visualization is traditionally performed by x-ray after its implantation. However, x-ray confirmation of the tip has been seen as inadequate due to the time it can take to perform this procedure and the amount of radiation to which NBs are exposed.

Thus, A8 points out the proposal to use ultrasound in the implantation of the PICC and during its migration to the desired location, which is related to the improvement in the success rates of insertion and the decrease in the number of punctures and complication rates.

**Class 3 – Capacitação Profissional frente a Manutenção do PICC (A1/A5).**

According to Jantsch, LB, et al (2014), the PICC should only be handled by a trained and qualified professional, thus certifying the safety of the newborn. Study A5 states that the handling of the device requires the attention of professionals, due to the significant incidence of adverse events and complications that may result from improper care, and the training and continuing education of the entire team regarding the handling of the catheter is extremely important.

The implantation and maintenance of the PICC are complex procedures and its use is associated with a large repertoire of complications that can increase neonatal morbidity and mortality. For this reason, the health team must master the specifics of the PICC, qualify for the implantation and handling of this device, institute protocols in hospital institutions, and always keep up to date with the technological innovations adopted in the handling of this PICC, in order to provide effective and quality care (Rangel, RJM, et al, 2019).

A1 highlights that, for the safe insertion of the PICC, the caliber must be defined by the professional, considering the adjustment of the lumen diameter for the weight and age of the NB, being suitable those that respect the size of the vessel. Thus, Santolim, TQ (2017) identifies that for a better functioning in the maintenance of the catheter and for measures to prevent infection to be effective, the training and continuing education of professionals are necessary, aiming at qualification strategies in care with a consequent minimization of early removal of the catheter and favoring the safety of the newborn.

The use of the PICC requires knowledge, skill and dexterity for its handling by health professionals, and the circumstances that compromise its permanence must be reduced (A1). Therefore, Silva, IMF, et al (2021) reinforces that the health team needs to be trained to ensure that the implantation site is properly defined, that the procedure is performed safely, reducing the number of puncture attempts, that the catheter is properly manipulated avoiding complications, especially obstruction and infection, and that the catheter is in fact a means of intravenous long-stay access.

## IV. CONCLUSION

In summary, the PICC is classified as an innovative technology, being indispensable and increasingly present in the daily life of NICUs, however, it presents some

adversities. The attribution of the health team goes beyond implantation, professionals have an important role when handling the catheter, which requires theoretical, practical knowledge and scientific basis.

Care related to maintenance is mainly focused on the control of nosocomial infection, with emphasis on adherence to aseptic techniques for handling the catheter, dressing and proper hand hygiene. Thus, the results indicate that there should be investment in training and continuing education programs, implementation of a care protocol, and conducting longitudinal studies that allow a better monitoring of the occurrence of complications associated with the use of this type of catheter.

It was also highlighted the need for research with better levels of evidence regarding the insertion and maintenance of the PICC in neonatology, with a view to providing more accurate results that, in a way, were considered to be a limitation of this study.

It is concluded that despite the occurrence of several complications resulting from the use of the PICC and relevant repercussions in connection with the health and safety of the neonate, this is, according to the literature, a safe and effective device that provides several benefits to NBs that require venous access for a prolonged period of time.

## REFERENCES


[1] Bahoush, G.; Salajegheh, P.; Anari, A. M.; Eshghi, A.; Aski, B. H. (2021). A review of peripherally inserted central catheters and various types of vascular access in very small children and pediatric patients and their potential complications. **Journal of Medicine and Life**, 14(3):298-309.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8321608/.

[2] Bardin, L. (2016). Análise de Conteúdo. São Paulo: Edições 70.

[3] Beiral, F. M. F. (2015). Prevenção de Infecção Primária da Corrente Sanguínea Relacionada ao Cateter Central de Inserção Periférica (PICC). Tese (Especialização MBA Gestão em Saúde), São Paulo, 24f. https://www.ccih.med.br/prevencao-de-infeccao-primaria-da-corrente-sanguinea-relacionada-ao-cateter-central-de-insercao-periferica-picc/.

[4] Beleza, L. O, et al. (2021). Atualização das recomendações da prática quanto ao cateter central de inserção periférica em recém-nascidos. **Rev enferm UERJ**, 29:e6129. https://www.e-publicacoes.uerj.br/index.php/enfermagemuerj/article/view/61291.

[5] Borghesan, N. B. A. (2015). Peripherally inserted central catheters (PICC): practical nursing team in intensive attention newborn. Dissertação (Mestrado) – Universidade Estadual de Maringá, Paraná, 114f. http://repositorio.uem.br:8080/jspui/handle/1/2334.

[6] Cavalcante, J. S., Lima, E. C. (2018). Complicações decorrentes do uso do cateter central de inserção periférica em neonatos e fatores associados. Trabalho de Conclusão de Curso (Bacharel em Enfermagem) - Centro Universitário do Planalto Central Aparecido dos Santos, 11f. https://dspace.uniceplac.edu.br/handle/123456789/76.

[7] Chang, L, et al (2021). Analysis of peripherally inserted central catheter-related complications: a retrospective cohort study of 2,974 children with blood diseases in a single center of China. **Ann Palliat Med**, 10(3):2971-2978. http://dx.doi.org/10.21037/apm-20-1771.

[8] Diniz, E. R. S.; Medeiros, K. S.; Silva, R. A. R.; Cobucci, R. N.; Roncalli, A. G. (2021). Prevalence of complications associated with the use of a peripherally inserted central catheter in newborns: A systematic review protocol. **PLoS ONE**, 16(7): e0255090. https://doi.org/10.1371/journal.pone.0255090.

[9] Duncombe D.C. (2018). A multi-institutional study of the perceived barriers and facilitators to implementing evidence-based practice. **J ClinNurs**, 27(5-6):1216-1226.https://pubmed.ncbi.nlm.nih.gov/29149462/.

[10] Gomes, T. C.; Sanchez, M. C. O.; Chrizostimo, M. M.; Xavier, M. L.; Lima, M. V. R.; Souza, D. F. (2019). Os cuidados de enfermagem na prevenção de infecção relacionados ao PICC em unidade neonatal. **Saúde Coletiva**, 09(48): 1404-1410. https://revistas.mpmcomunicacao.com.br/index.php/saudecoletiva/article/view/103.

[11] Gonçalves, J. (2017). O uso do PICC em pacientes adultos, indicações, complicações e cuidados de enfermagem: revisão da literatura. Tese (Especialização) – Universidade do Vale do Rio dos Sinos, Porto Alegre, 1-21. http://www.repositorio.jesuita.org.br/handle/UNISINOS/6798.

[12] Jantsch, L. B.; Neves, E. T.; Arrué, A. M.; Kegler, J. J.; & Oliveira, C. R. (2014). Utilização do cateter central de inserção periférica em neonatologia. **Revista Baiana de Enfermagem**, 28(3):244-25. https://periodicos.ufba.br/index.php/enfermagem/article/view/10109.

[13] Kochanowicz, J. F, et al (2022). Catheter-related bloodstream infections in infants hospitalized in neonatal intensive care units: a single center study. **Scientific Reports**, 12:13679. https://doi.org/10.1038/s41598-022-17820-w.

[14] Lui, A. M. L, et al. (2018). Cuidados e limitações no manejo do cateter central de inserção periférica em neonatologia. **Revista de Enf do Centro-Oeste Mineiro**, 8:e1918. http://seer.ufsj.edu.br/index.php/recom/article/view/1918.

[15] Mittang, B. T.; Stiegler, G.; Kroll, C.; Schultz, L. F. (2020). Peripherally inserted central catheter in newborns: removal factors. **Rev baiana enferm**, 34:e38387. https://www.researchgate.net/publication/346938053_peripherally_inserted_central_catheter_in_newborns_removal_factors.

[16] Oliveira, C. R.; Neve, E. T.; Rodrigues, E. C.; Zamberlan, K. C.; Silveira, A. (2014). Peripherally inserted central catheter in pediatrics and neonatology: possibilities of systematization in a teaching hospital. **Escola Anna Nery Rev Enf** ,18(3):379-385. https://doi.org/10.5935/1414-8145.20140054.

[17] Rangel, R. J. M.; Castro, D.S.; Amorim, M.H.C.; Zandonade, E.; Christoffel, M. M.; Primo, C. C. (2019). Practice of Insertion, Maintenance and Removal of Peripheral Inserted Central Catheter in Neonates. **R. pesq cuid fundam**, 11(2):278-84. http://seer.unirio.br/index.php/cuidadofundamental/article/view/6425.

[18] Renfeng, L.; Xia, C.; Tian, S.; Lei, X. (2019). Application of peripherally inserted central catheters in critically ill newborns experience from a neonatal intensive care unit. **Medicine**, 98:32. https://pubmed.ncbi.nlm.nih.gov/31393341/.

[19] Santolim, T. Q. (2017). Benefícios e riscos do cateter central de inserção periférica (CCIP). Experiência em 1023 procedimentos. Dissertação (Mestrado) – Faculdade de Medicina da Universidade de São Paulo, 101f. https://www.iothcfmusp.com.br/pt/defesa/beneficios-e-riscos-do-cateter-central-de-insercao-periferica-ccip-experiencia-em-1023-procedimentos/.

[20] Silva, I. M. F.; Barbosa, G. L. P.; Silva, M. A. X. M. (2021). Infecção de corrente sanguínea associada ao uso de PICC em neonatos: conhecimento de graduandos de enfermagem sobre os fatores relacionados e estratégias utilizadas para a prevenção. **Revista Ibero-Americana**, 7(11): 2675 – 3375. https://periodicorease.pro.br/rease/article/view/3089.