

Interventional ultrasound for implantation and monitoring of peripherally inserted central venous catheter: scoping review

Ultrassonografia Intervencionista para implantação e monitoramento de cateter venoso central de inserção periférica: scoping review

Ultrasonido intervencionista para implantación y monitorización de catéter venoso central insertado periféricamente: revisión del alcance

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ABSTRACT

Objective: to discuss the available evidence on the use of ultrasound in insertion and maintenance of peripherally inserted central venous catheters in critical neonates. **Method:** this scoping review was based on recommendations by experts from the Joanna Briggs Institute. The population, concept and context (PCC) approach was used to identify the research question. The study was carried out between January and March 2020 in three databases and Google Scholar. **Results:** a sample of 15 articles published in several countries between 2016 and 2020, in English and Portuguese, was obtained in the 354 publications found. Most showed ultrasound point of care (POCUS) being used to choose the venous site or locate the catheter tip. **Conclusion:** further studies are needed to investigate the effectiveness of POCUS in insertion and maintenance of epicutaneous catheters in critical neonates, to support its adoption as the gold standard in this clientele. Handling by nurses is still incipient.

Descriptors: Infant, Newborn; Intensive Care Units, Neonatal; Ultrasonography, Interventional; Catheters.

RESUMO

Objetivo: discutir as evidências disponíveis sobre uso de ultrassonografia na implantação/manutenção de cateter venoso central de inserção periférica no neonato crítico. **Método:** *scoping review*, baseada nas recomendações de especialistas do *Joanna Briggs Institute*. Para identificar a questão de investigação foi seguida a versão PCC – *Population, Concept and Context*. As buscas foram realizadas entre janeiro e março de 2020, em três bases de dados e no *Google Scholar*. **Resultados:** das 354 publicações encontradas resultou uma amostra de 15 artigos, publicados em diversos países, entre 2016 e 2020, em inglês e português. A maioria evidenciava uso da *ultrasound point of care* (POCUS) para escolha do sítio venoso ou localização da ponta do cateter. **Conclusão:** são necessários mais estudos, investigando a efetividade da POCUS na inserção/manutenção de cateter epicutâneo em neonatos críticos, para basear sua adoção como padrão ouro nesta clientela. O manejo por enfermeiros ainda é incipiente.

Descritores: Recém-Nascido; Unidades de Terapia Intensiva Neonatal; Ultrassonografia de Intervenção; Cateteres.

RESUMEN

Objetivo: discutir la evidencia disponible sobre el uso de el ultrasonido en la inserción y mantenimiento de catéteres venosos centrales de inserción periférica en neonatos críticos. **Método:** esta revisión de alcance se basó en recomendaciones de expertos del Instituto Joanna Briggs. Se utilizó el enfoque de población, concepto y contexto (PCC) para identificar la pregunta de investigación. El estudio se realizó entre enero y marzo de 2020 en tres bases de datos y Google Scholar. **Resultados:** en las 354 publicaciones encontradas se obtuvo una muestra de 15 artículos publicados en varios países entre 2016 y 2020, en inglés y portugués. La mayoría mostró que se usaba el punto de atención de ultrasonido (POCUS) para elegir el sitio venoso o ubicar la punta del catéter. **Conclusión:** se necesitan más estudios para investigar la efectividad de POCUS en la inserción y mantenimiento de catéteres epicutáneos en neonatos críticos, para respaldar su adopción como el estándar de oro en esta clientela. El manejo por parte de enfermeras es aún incipiente.

Descriptores: Recién Nacido; Unidades de Cuidado Intensivo Neonatal; Ultrasonografía Intervencional; Catéteres.

INTRODUCTION

In the care of the newborns (NBs) admitted to Neonatal Intensive Care Units (NICUs), great technological advances in the area of health sciences, added to the provision of quality multi-professional care, have brought considerable growth in the survival rate of these patients, even among extremely premature infants.

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The modernization of the NICUs, as well as technical and scientific improvement in the management of high-risk newborns, provided a leap in the quality of care. Intravenous therapy (IVT), which is essential for maintaining the life of the critical neonate, is one of the procedures that mirror this technological advance. Biocompatible catheters, fixators, industrial dressings and devices, used in the proper selection of the blood vessel, have recently been developed and have maximized the therapeutic results, with greater cost/benefit ratio^{1,2}.

For the realization of IVT, it is essential to enable reliable venous access, using devices such as Teflon catheter over needle, umbilical catheter, peripherally inserted central venous catheter (PICC), and central venous catheter¹. PICCs are devices made of silicone and polyurethane (materials of low thrombogenicity, biocompatible, and biostable), introduced by superficial vein, upper or lower end, until they reach the distal third of the superior vena cava or the proximal third of the lower vena cava, thus conferring central access features. Nowadays, they are the most used long-term devices to enable IVT in Neonatology.

Their implantation is an elective procedure, usually scheduled to replace the venous umbilical catheterization or peripheral access. It is indicated in conditions like hemodynamic monitoring, infusion of hyperosmolar solutions, such as parenteral nutrition, use of irritating/vesicant medications, in addition to antibiotic therapy longer than six days. Extreme pre-term infants who receive nutrition through an epicutaneous catheter have significant weight gain, shorter hospital stay, and lower infection rates when compared to babies submitted to multiple peripheral punctures²⁻⁴.

However, establishing safe and durable venous access via the periphery can be challenging when the patient is a critical NB. Each vessel will present particular difficulties, risks, and complications. And all will have a small diameter. In this context, accessing a central route using an epicutaneous catheter, with a strict aseptic technique and adopting best practices, reduces adverse events, contributing to patient safety. Ultrasound guidance (USG), used for placing the PICC (acronym for peripherally inserted central catheter) improves placement accuracy, reducing insertion time, failure rates, and complications related to this device⁵, as well as it helps to reduce radiation exposure, as there are indications that radiographic monitoring of this catheter contributes a lot to the exposure of the NBs, with a deleterious effect. There are reports that very low birth weight newborns are submitted, on average, to 25 radiographs during their stay in the NICU. Therefore, the adoption of institutional insertion protocols that advocate the use of USG is desirable⁶.

For the Brazilian law, medical professionals are legally responsible for the surgical techniques of central venous catheterization. Within the nursing team, umbilical catheterization and PICC are exclusive to nurses, as long as they are submitted to professional qualification and/or training³.

To prevent complications, estimated at up to 33%, the ability to insert is essential⁷. According to the guidelines of the Infusion Nursing Society (INS) of Brazil, the formation of a trained and structured work team, a team dedicated exclusively to IVT, makes working with excellence a reality, ensuring best practices. The guarantee of continuing education for professionals and students in relation to the installation of vascular accesses is another gain mentioned⁸.

In 2019, the Nursing Service of a University Hospital in the state of Rio de Janeiro, started to work on the implementation of the catheter team, with the objective of adopting the best practices in venous catheters, aiming at quality of care, and valuing the responsibility for patient safety. The strategic objective was to standardize the insertion, fixation, maintenance, and removal of vascular accesses. Once the work began, sector leaders were established. In order to achieve the technologies that reflect excellence in the area, the state of the art was realized.

This article is the report of a proposed scoping review study to discuss available evidence on the use of USG in the implantation/maintenance of PICCs in critical neonates. More specifically, we seek to answer the following guiding question: What is the current scientific evidence on the use of USG in the implantation and maintenance of PICCs in critical neonates?

METHOD

The study was designed as a scoping review, in accordance with a method structured by the Joanna Briggs Institute⁹, which makes it possible to map fundamental concepts, clarify research areas, and identify knowledge gaps¹⁰. As in other literature review methodologies, the search is guided by the choice of the research question. And the results found are filtered by applying inclusion and exclusion criteria. However, this inclusion/exclusion is not guided by the quality of the works (since this evaluation is not part of the objective of the scoping review), but by the relevance in the discussion of the theme. The selected data represent an essentially qualitative synthesis¹¹.

Another peculiarity of the method is the discussion of the results, not their analysis, which can be carried out by specialists in the field, seeking to contextualize and synthesize productions, disseminating knowledge¹¹.

To construct the research question, in January 2020 the Population, Concept and Context (PCC) strategy⁹ was used, with P being the type of population (newborn), C the concept (implantation and maintenance of the peripherally inserted central venous catheter using USG), and C the context (neonatal intensive care unit).

This initial stage of the protocol served to identify the research question and to build the search strategies. It was intended to answer the following guiding question: What scientific evidence is available on the use of USG in the implantation and maintenance of PICCs in critical NBs?

The selection of articles was carried out independently from January to March 2020 by two researchers. Through the Virtual Health Library (*Biblioteca Virtual em Saúde*, BVS) portal, the LILACS and IBICS databases were consulted. The National Library of Medicine (PubMed) interface served as access to its main component, the Medical literature Analysis and Retrieval System Online (MEDLINE). The Scientific Electronic Library Online (SciELO) was the last electronic portal to compose this search phase. The selected descriptors were “newborn”, “catheter”, “catheterization”, “ultrasonography” and “cannulation” and their variations in Spanish and Portuguese, as well as related/synonymous free terms. To extract the descriptors, the controlled vocabularies of the health area from the Health Sciences Descriptors (*Descritores em Ciências da Saúde*, DeCs) and the Medical Subject Headings (MeSH) were consulted. For the proper correlation of terms, the Boolean operators “AND” and “OR” were used.

The titles included in the review met the following criteria: being published between February 2015 and February 2020; in national and international journals; being available in Portuguese, English or Spanish; and answering the guiding question. It was decided to establish a time frame of the last five years (2015 to 2020), in order to retrieve more recent publications on the theme addressed. Publications in pairs and texts not linked to the theme were excluded. This search strategy and the quantity obtained in each database can be seen in Figure 1.

DATA BASE	SEARCH STRATEGY	QUANTITATIVE	
BVS	tw:(Newborn OR "recem-nascido" OR "recien nacido" OR neonato* OR neonata* OR neonate*) AND (tw:(Catheter* OR cateter* OR PICC OR CCIP OR canula OR cannulation OR cannula)) AND (tw:(Ultrasonography OR ultrasonografia OR ultrassom OR ultrasonografia OR ultrasonido OR ultra-som OR ecografia)) AND (instance:"regional") AND (db:("LILACS" OR "IBICS")) AND year_cluster:("2015" OR "2016" OR "2017" OR "2018" OR "2019"))	Identified	23
		Excluded by title	13
		Duplicates	01
		Selected for reading the abstracts	09
		Selected for full-text reading	04
		Selected for discussion	01
PUMED	((Newborn[mh] OR Newborn[tiab]) AND ((Catheters[mh] OR catheter*[tiab] OR PICC[tiab] OR cannula[tiab] OR cannulation[tiab]) AND (Ultrasonography[mh] OR Ultrasonography[tiab] OR ultrasound[tiab]))) AND ("2015"/01/09"[PDat] [PDat] : "2020/01/06"[PDat])	Identified	261
		Excluded by title	210
		Duplicates	06
		Selected for reading the abstracts	45
		Selected for full-text reading	10
		Selected for discussion	09
SciELO	newborn AND catheter* AND ultrasonography OR ultra-som AND year_cluster:("2015" OR "2016" OR "2017" OR "2018" OR "2019"))	Identified	35
		Excluded by title	27
		Duplicates	03
		Selected for reading the abstracts	05
		Selected for full-text reading	0
		Selected for discussion	0

FIGURE 1: Article search and selection protocol in databases

Regarding the Grey Literature, a search was performed in Google Scholar for titles identified in study references captured or using keywords, obeying the same search criteria that in the search in the PubMed databases.

All the data were extracted by two authors and confirmed by a third, with ample experience in Scoping Reviews. The results were synthesized by the four authors, by consensus.

RESULTS

Of the 319 studies identified in the databases, after exhaustive reading of their titles and abstracts, 14 were selected, as they met the inclusion criteria.

Among those selected, four were excluded because they did not fully address the theme, referring only to central venous catheters other than PICCs or to a diverse population of critical NBs. The remaining 10 studies were analyzed and included in the research.

The searches in Google Scholar resulted in the addition of 35 publications. After reading abstracts and/or full text, five documents were selected, two by searching with keywords and three found in references from other studies.

At the end, the sample of this review totaled 15 papers selected for discussion. The full process of searching and selecting the studies in this review is represented in a flowchart (Figure 2), in compliance with the JBI recommendations, according to a checklist adapted from the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR)⁹.

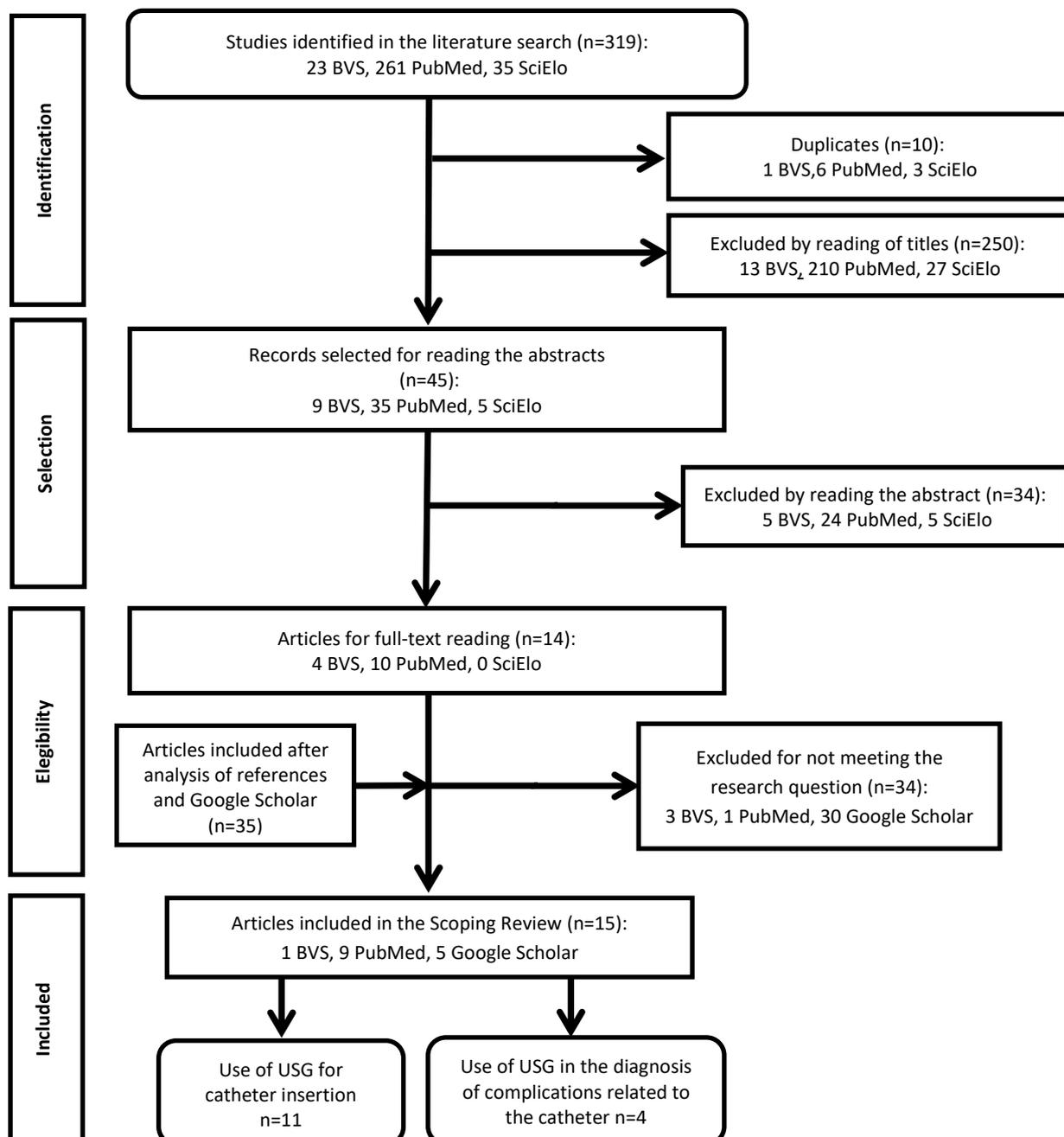


FIGURE 2: Flow diagram: integral process for the search and selection of publications. Niterói, RJ, Brazil, 2020.

The fifteen studies included were published between 2016 and 2020 (Figures 3 and 4). No studies from 2015 were used. In 2016, on the contrary, there was a strong concentration, with six published studies¹⁹⁻²⁴, followed by the year 2018, with four¹⁵⁻¹⁸. In relation to the place where the research studies were carried out, Europe¹² was the setting for one study, as were Eurasia¹⁶, Asia²⁰ and Oceania²⁶. Eleven were developed in the Americas, eight of which were from the United States^{13,14,18,19,21-24} and three from Brazil^{15,17,25}. Three documents were made available in Portuguese^{15,17,25}, the others in English^{12-14,16,18-24,26}.

Author/Place Database/Year	Objectives	Study design	Main results	Conclusions
Singh, et al ¹² Reino Unido Google Scholar 2020	To provide evidence-based guidelines for the use of POCUS (Point of Care Ultrasound) in critically ill NBs and children.	Systematic review	The specialists agreed with 39 of the 41 recommendations for the use of POCUS in critically ill NBs. Regarding vascular POCUS: to guide the PICC, it results in a higher cannulation rate in the first attempt when compared to the anatomical reference technique; useful to locate the tip of the catheter in NBs and children; can decrease X-ray exposure and line manipulation, if used to confirm the position of the PICC tip, post placement.	The evidence-based guidelines established for the use of POCUS in neonates and critically ill children will be useful in optimizing the use of the technique, training programs, and additional research, which are urgently needed, given the poor quality of the available evidence.
Suell J, et al ¹³ Estados Unidos PUBMED 2020	To describe the real-time (RT) monitoring experience of locating the tip of a PICC catheter using USG, in a 2 kg NB with heart disease, submitted to the blind insertion technique, by standard anatomical measurement.	Qualitative case study	Both the USG in RT and the X-ray identified the poor positioning of the tip of the catheter, directed to the left internal jugular vein. The USG-guided repositioning attempt was performed, using the same previous measure. The procedure was ended when the ultrasound showed the upper tip of the device in the left brachiocephalic vein, confirmed by X-ray.	The use of USG in real time made it possible to evidence the anomalous positioning of the PICC, and manipulation of the extremity, resulting in a better positioning of the central line.
Motz P, et al ¹⁴ Estados Unidos PUBMED 2019	To evaluate the feasibility, for use by experienced radiologists from a Seattle hospital, of a protocol for locating the tip of a PICC inserted in NBs.	Pilot study, prospective, quantitative, interventionist cohort	14 scans were carried out in 11 neonates, eight of which weighed less than 1.5 kg. A chest X-ray was performed before the USG and its result was not passed on to the radiologist responsible for the USG. The location of the PICC by USG was identical to the X-ray in all the scans performed.	The tested protocol proved to be feasible for use in NBs but, to be adopted in the neonatal ICU, it would be necessary to continue the study, involving a larger, more significant sample.
Barreiros L, et al ¹⁵ Brasil BVS 2018	To determine the incidence of pericardial effusion and cardiac tamponade in NICU NBs, with an emphasis on the relation between PICC and diseases. To assess the role of bedside USG in the diagnosis.	Documentary, retrospective, qualitative study	A retrospective evaluation of 426 medical records of the NBs admitted to the NICU was carried out. The data showed 285 USG performed at the bedside. Six cases of pericardial effusion were found, 04 with obstructive shock and the need to perform pericardial drainage. All the patients improved. The incidence of pericardial effusion was 2.4 cases per year.	The incidence of pericardial effusion is low in NBs. However, early diagnosis is essential in cases of abrupt installation, due to the risk of morbidity and mortality. All the cases were diagnosed by bedside USG, validating the importance of this test in screening for complications.
Sancak S, et al ¹⁶ Turquia PUBMED 2018	To report the experience of using USG to confirm PICC positioning in a 33-week-old gestational age NB, inserted by the traditional technique, which evolves with complications.	Qualitative case report	The post-puncture position control, performed with non-contrasted X-ray, showed the catheter in a peripheral position. After clinical worsening, USG was performed, with the catheter in the left pulmonary artery and fluid in the left lung (parenteral nutrition).	Using USG to confirm the position of the PICC can bring benefits in relation to the use of X-ray by avoiding radiation exposure, and can be used in real time, from the puncture to the certification of the location of the catheter tip.
Torres R ¹⁷ Brasil Google Scholar 2018	To evaluate the use of POCUS by an intensive care specialist to assist in the diagnosis and monitoring of critically ill children in a Neonatal ICU.	Prospective, interventionist, quantitative	Three cases of cardiac tamponade related to the use of PICC were detected, 02 of them being in clinical suspicion. In all, echocardiographic diagnosis was essential for the decision to perform pericardiocentesis. The event was confirmed as a complication of the PICC, due to the biochemical characteristics of the drained liquid, identical to the infused liquids.	The results showed a better diagnostic performance when POCUS was used as a complement to the physical examination, improving or modifying the initial hypothesis and optimizing medical procedures. It confirmed a complication correlated to the poor positioning of the PICC in the three cases evaluated.
Zaghoul N, et al ¹⁸ Estados Unidos Google Scholar 2018	To analyze the agreement between X-rays and POCUS in determining the tip of central catheters. To examine poor positioning by performing serial POCUS.	Observational, prospective, quantitative	54 NBs were evaluated, with 108 X-ray "pairs" and POCUS images. The agreement coefficient (AC1) in relation to the position/incorrect position of the CVC tip was high (PICC-AC1 = 0.94). The rate of poor positioning of the CVC tip decreased over time.	The agreement between the two exams for the tip of the PICC was high, especially in NBs <1000 g. The data suggest POCUS as efficient for initial confirmation and follow the position of the CVC tip.

Figure 3: Synoptic Chart related to 2018, 2019 and 2020. Niterói, RJ, Brazil, 2020.

Author/Place Database/Year	Objectives	Study design	Main results	Conclusions
Ares Hunter ¹⁹ Estados Unidos PUBMED 2017	To describe the multiple indications for the use of CVC and the different devices available for central venous access.	Systematic review	Major systematic reviews with meta-analysis concluded that USG guidance in CVC placement is safer than the traditional technique, at least for internal jugular vein access. Another evidence was the relation between the proper placement of the catheter tip and a reduction in complications.	Several techniques for placing CVCs, such as anatomical marks, are still valid. But USG guidance can lessen complications. Implantation/Maintenance protocols of CVCs are essential for reducing diseases.
Telang, N et al ²⁰ Índia PUBMED 2017	To estimate the diagnostic usefulness of USG in real time in detecting poor position of the tip of central lines.	Observational, pilot, quantitative	33 patients were chosen for insertion of the PICC. USG and X-ray were used to locate the tip of the post-insertion catheter in 21 cases. In 10 cases, a <i>bolus</i> of saline solution was required. Another 2 were found in an anomalous position.	The study indicated a positive predictive value for the use of USG in real time, which may decrease the time necessary for the start of infusions.
Johnson K et al ²¹ Estados Unidos PUBMED 2016	To retrospectively evaluate the effectiveness of using USG in obtaining venous access in neonates <1.5 kg, with a history of previous failure, in insertions, performed by nurses.	Observational, cohort, retrospective, qualitative	Ten NBs were selected to use the USG in an attempt to establish a venous line, after a nursing diagnosis of difficult venous access, even with the use of transilluminescence or infrared. The USG was performed by physicians. The preferred veins were from the upper limbs. All the punctures were successful. There were no complications.	The use of USG to guide the insertion of epicutaneous catheter in very low weight newborns can be considered an effective technique, with low risk of complications, but it requires training and practice for optimal use of the apparatus.
Nguyen J ²² Estados Unidos Google Scholar 2016	To assess the clinical benefit, practical considerations for implementation and limitations of the USG for placing CVCs (umbilical and PICC) in the NICU.	Bibliographic research	Five studies on CVC insertions, guided by USG, and seven studies describing post-insertion USG were determined to be relevant to the purpose of the review and discussed. The literature seemed insufficient to recommend USG as an X-ray substitute to confirm the tip of the catheter.	The use of USG during CVC insertion followed by X-ray has the potential to reduce manipulations, the need for a new X-ray and complications.
Richter R et al ²³ Estados Unidos PUBMED 2016	To describe the results of a new technique of epicutaneous catheterization by cannulation of the distal superficial femoral vein (DSFV), guided by USG in infants with heart disease in the NICU.	Retrospective cohort descriptive, qualitative	Of the 31 children submitted to the technique, 28 were successful, requiring the expense of 34 devices (82% of success). No inadvertent arterial puncture rates have been reported. The infection rate associated with the technique was 4.6%. The rate of occurrence of deep vein thrombosis was 11.8%.	The use of DSFV as the first choice for insertion of PICC in children with congenital heart disease has shown high rates of success and longevity (from 16 to 123 days, a mean of 39 days of catheter stay), leaving the cardiac area free for surgical exploration.
Saul D et al ²⁴ Estados Unidos PUBMED 2016	To evaluate the effectiveness of USG, compared to X-ray, for locating therapeutic devices (including umbilical catheter and PICC).	Pilot study, prospective, quantitative	Thirty USG and X-ray studies were performed in 25 patients, where 11 underwent epicutaneous catheterization. Of these, 10 were visualized, and 3 were poorly positioned. In 1 case, the tip of the catheter was not seen.	USG was effective for assessing the location of the catheters, a result that supports the need for more training for the adoption of USG as a routine for evaluating supportive devices in intensive care.
Von-Jakitsch C et al ²⁵ Brasil Google Scholar 2016	To check in the health establishments of Vale do Paraíba in São Paulo the use of the PICC catheter and the professionals involved in the process.	Observational, descriptive, quantitative	The PICC was used in 70% of the establishments observed, using protocols in the processes. The nurse was responsible for inserting and removing these devices. The minority used image-guided puncture for insertion.	In the studied scenarios, the PICC was widely used since 2005. The competence of the qualified nurse was recognized, being responsible for the performance on this device.
Ye X et al ²⁶ Austrália PUBMED 2016	To fix in a tertiary hospital, the probability of venous thrombosis of the upper limb (VTUL) in patients with PICC or CVC, <i>versus</i> patients with no catheter.	Retrospective, quantitative	Of the 876 USG performed on 637 patients, 213 showed VTUL. In 38 (of 85) NBs with PICC, in 36/103 of the patients with CVC, and in 139/688 of the patients without catheter, <i>in situ</i> VTUL was diagnosed. In the period, 1,855 PICCs and 2,435 CVCs were inserted in the hospital. The incidence rate of VTUL was 2.05% in patients with PICCs and 1.48% in those with CVCs.	The catheters predispose to the formation of VTUL. The PICCs are more likely to be associated with VTUL than the CVCs and have less time for symptomatic clotting.

Figure 4 : Synoptic Chart related to 2016 and 2017. Niterói, RJ, Brazil, 2020.

The authors had initial medical training, except for a Brazilian nurse²⁵. As for the approach, seven studies were quantitative^{14,17,18,20,24-26} and eight qualitative^{12,13,15,16,19,21-23}. Among the quantitative, four were observational, longitudinal, and prospective^{14,17,18,20,24} (two pilots, blinded^{14,24}), one descriptive and observational²⁵, and one retrospective and observational²⁶. Of the eight qualitative studies analyzed, one was an international guideline¹² and seven were articles (an experience report¹³, one case report¹⁶, two from a literature review^{19,22}, and three retrospective, documentary reports^{15,21,23}).

The studies were grouped into two axes of thematic approach: use of USG in the insertion of the PICC catheter, and use of USG in the diagnosis of complications related to the catheter. Most of the publications dealt with the use of USG in real time, at the bedside, made possible by the advent of portable sound systems.

In seven original articles, developed with the objective of evaluating the use of portable ultrasound in the insertion technique, the focus was distributed between the choice of the insertion site^{21,23,25}, and the location of the catheter tip^{13,18,20,24}. In the document containing expert recommendations¹² and in the two literature reviews^{19,22}, the use of ultrasound for venous visualization, vascular progression, and location of the catheter tip was discussed. Another three original articles^{15,16,26} and a dissertation¹⁷ evaluated the use of USG in the post-insertion phase, for diagnosis of complications related to the PICC, such as pericardial effusion¹⁵, cardiac tamponade¹⁷, deep vein thrombosis²⁶, and pleural effusion by parenteral nutrition¹⁶. Of these, one disclosed the technique called TNEcho (Targeted Neonatal Echocardiography)¹⁶ and another did not clarify as to the use of a portable device²⁶.

Finally, one study aimed to analyze the viability of a catheter tip location protocol, when used by radiologists¹⁴. And another, to know the use of the PICC, the processes adopted and the professionals involved, in hospitals in the inland of São Paulo²⁵.

DISCUSSION

The use of the PICC in neonatology consists of a specialized and preferred practice, due to the possibility of insertion at the bedside, without the need for surgical intervention or harmful displacements to the unstable NB; moreover, it offers less risk for bloodstream infection when compared to the non-tunneled catheter^{19,22}.

USG has achieved great acceptance and utility in the clinical practice since the advent of portable devices, which enabled the technique called POCUS^{12,15} (ultrasound performed and interpreted at the bedside), or RTUS (real-time ultrasound)²⁰. Its use has spread among non-radiologist medical professionals, who have incorporated it into their daily practice, exceeding the limits of specialties. The technique is defended as useful to establish several diagnoses and advantageous for not using ionizing radiation, allowing dynamic studies and not being invasive^{12,27}.

In the context of IVT, the adoption of POCUS in institutional protocols for insertion and maintenance of the PICC extended the implementation of this imaging method to nurses, in countries where this professional is responsible, along with the physician, for the insertion of this device, which reflected in the rules that regulate the professional activity³. However, only one Brazilian observational study showed this practice as routine, and as competence of nurses, to guide venipuncture, stating that, even though predicted, the use of POCUS occurred in the minority of insertions²⁵. In the opinion of the rapporteur COFEN 243/2017, there is an analysis of several regional regulations that support the use of USG by nurses qualified in the PICC insertion procedure, limited to the visualization and choice of the vessel to be punctured, to optimize the introducer, catheter, and guide (for the modified Seldinger technique)^{3,28,29}.

A 2016 American study evaluated the experimental use of ultrasound for the insertion of PICCs by medical professionals, in premature infants weighing less than 1.5 kg. The echo-guided insertions were performed after a nursing diagnosis of difficult venous access, with 100% success. In the institution, USG was not applied in the first choice and the nursing protocols provided for the selection of the vessel for the insertion of PICCs by the palpation technique, use of transillumination or infrared²¹, with a success rate above 90%.

Since 2013, the INS determines which nurses are as competent to use USGs as medical professionals, provided they are trained and qualified^{3,31}, which may have contributed to the adoption of this practice in nursing protocols. But the adoption of this innovation as the gold standard in the insertion of PICCs in neonates has not even been evidenced. On the contrary, what was exposed by several authors is that the choice of USG as the most appropriate means of visualizing the PICC insertion site is considered the gold standard in adult patients, based on strong evidence^{12,18,22}. But there is no consensus on its applicability in critical neonates¹².

In February 2020, a document was published prepared by twenty specialists, mostly pediatric or neonatal intensivists, being the result of an extensive literary research, and in compliance with the International Appraisal of Guidelines for Research & Evaluation (AGREE). There was agreement in 39 of 41 indications for the use of cardiac, pulmonary, vascular, cerebral, and abdominal POCUS in critically ill neonates and children. Of these, 28 were based on evidence of moderate quality¹². The authors concluded that POCUS is proficient for insertion and location of the PICC tip. They also considered its recommendations useful for using POCUS in those patients and for guiding training programs. But they defended urgency in additional research studies, given the poor quality of evidence available in the studies evaluated for the elaboration of the guideline¹². Most of the studies discussed in this scoping review are observational, qualitative, documentary, literature or field, limited by small samples, corroborate this finding, thus disclosing low level evidence^{13,15,16,20,21,23,24}.

Another study, of the systematic review type, diverged, maintaining strong evidence coming from large studies with meta-analysis, linking the use of ultrasound to the PICC procedure, from the choice of the venous site, through the progression to the visualization of the tip of the device, showing USG advantages in all the implantation processes. The

authors even concluded that the indication of POCUS for PICC in extremely low birth weight NBs is adequate, due to its excellent success rate and low risk of complications¹⁹.

For the location of the catheter tip, indispensable for the beginning of IVT, X-ray examination is still the most used method²²; and with repetitions, in case there is a need to reposition the venous device^{12,22}. This is disadvantageous, as well as the need for an intact and large vascular network for insertion³². A number of authors argue that POCUS brings advantages to the procedure, such as the exact location of the vessel light, accurate measurement of its diameter^{12,31}, and visualization of deep veins for PICC establishment, such as the internal jugular (IJV) and femoral veins^{12,22,23}. The use of POCUS to visualize the IJV has advantages over the technique by anatomical reference, such as shorter insertion time, high success rate on the first attempt, and a higher percentage of the device tip location^{12,22}.

A literature search covered a study by experienced American neonatologists, who implanted PICCs with POCUS; as a result, the total procedure time was reduced by 40%. The need for repositioning between the catheters implanted by USG and additional manipulations was lower when compared to the standard method. Five out of twenty infants (25%) with POCUS-guided PICCs needed line adjustments based on X-rays compared to 19 of the 28 infants (68%) with the standard implantation²².

A retrospective cohort described cannulation of the distal superficial femoral vein (DSFV) guided by real-time ultrasound for PICCs in critically ill infants with congenital heart disease. The option for using the USG was due to the lack of superficial points used as a reference for the identification of the access. It was concluded that, despite the limitations of the study, this choice of access obtained a high success rate, sufficient longevity and flexibility for IVT, requiring broader prospective studies in the context of perioperative care of these patients, as well as describing the complications associated with this technique²³.

So much technological innovation in IVT requires the NICU professionals to constantly strive to renew their knowledge and develop new skills²⁷. A study inferred that the physician's practical experience would be essential to effectively execute the choice of the puncture site, based on an ultrasound image at the bedside. But it did not discuss how many hours of training and practical activities would be needed to attain expertise²³. Another Brazilian study suggested that the institutions implement training programs for nurses, contributing to the improvement of these professionals and patient safety, since scientific evidence correlates the use of this technology to increasing the success of implantation in a difficult venous network²⁵.

CONCLUSION

POCUS is a promising innovation for use in neonatal intensive care. The miniaturization of USG machines, with maintenance of image quality and cost reduction, paved the way for the use of this technique in various diagnostic procedures, in addition to the use for insertion and maintenance of the PICC. This turns POCUS into a highly cost-effective practice, now supported by the opinion of international experts.

The trend is for POCUS to be adopted as the first choice for choosing the vein to be cannulated. As well as like an alternative method to guide the insertion of the PICC, due technical possibility (since, to perform these two stages of the insertion process using USG, it would be necessary to use a single transducer, without including other materials), which will legitimize the professional nurse as qualified for the technique worldwide. However, recent studies do not exclude control X-rays of the position of the tip of the PICC, indicating the performance of both techniques, comparatively, pointing out POCUS as a supplement to the radiological examination. Future studies, with greater impact, can support the positive predictive value of POCUS.

As a limitation of the process of this scoping review, we signal the choice of three databases that avail studies in the health area of Brazil, Latin America, and the USA in over 70 countries. This may have excluded studies published in several countries, with possible important results for the theme. It is also worth highlighting the fragility of the studies included in this scoping review. According to some authors, the generalization of many of the results obtained would need to be supported by other studies, with larger samples.

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