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REVIEW

TECHNOLOGICAL RESOURCES IN NEONATOLOGY: EVIDENCE ON THE SELDINGER TECHNIQUE IN CENTRAL VENOUS CATHETERIZATION

RECURSOS TECNOLÓGICOS EM NEONATOLOGIA: EVIDÊNCIAS SOBRE A TÉCNICA DE SELDINGER NO CATETERISMO VENOSO CENTRAL

RECURSOS TECNOLÓGICOS EN NEONATOLOGÍA: EVIDENCIA SOBRE LA TÉCNICA SELDINGER EN CATETERISMO VENOSO CENTRAL

Izabela Linha Secco[1]
Higor Pacheco Pereira[1]
Andrea Moreira Arrué[1]
Mitzy Tannia Reichembach Danski[1]

[1]Universidade Federal do Paraná - UFPR, Enfermagem. Curitiba, Paraná - Brasil.

Corresponding Author: Izabela Linha Secco
E-mail: izabelasecco_enf_@hotmail.com

Authors' Contributions:
Conceptualization: Izabela L. Secco; Higor P. Pereira; Andrea M. Arrué; Mitzy T. R. Danski; Data Collection: Izabela L. Secco; Higor P. Pereira; Andrea M. Arrué; Investigation: Izabela L. Secco; Higor P. Pereira; Andrea M. Arrué; Methodology: Izabela L. Secco; Higor P. Pereira; Andrea M. Arrué; Project Management: Andrea M. Arrué; Mitzy T. R. Danski; Statistical Analysis: Izabela L. Secco; Higor P. Pereira; Andrea M. Arrué; Supervision: Andrea M. Arrué; Mitzy T. R. Danski; Visualization: Izabela L. Secco; Higor P. Pereira; Andrea M. Arrué; Mitzy T. R. Danski; Writing – Original Draft Preparation: Izabela L. Secco; Higor P. Pereira; Andrea M. Arrué; Writing - Review and Editing: Izabela L. Secco; Higor P. Pereira; Andrea M. Arrué; Mitzy T. R. Danski.

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Luciana Regina Ferreira da Mata

ABSTRACT

Objective: to identify scientific evidence about the Seldinger technique in the insertion of central venous catheters in Neonatology. Method: integrative review in SCOPUS, MEDLINE, Web of Science, Science Direct, Alliance for Vascular Access Teaching and Research databases and citations of interest. Held in December 2020, without time limits. Results: 804 articles were found. Of these, 18 were included. The publications covered the period from 1982 to 2016. International studies predominated, with low levels of evidence, developed by anesthesiologists and surgeons. The Seldinger technique was considered an assertive method that guarantees a minimum incidence of complications and offers patient safety. Furthermore, it is less stressful compared to direct puncture. Conclusion: it is a technology that needs to expand the number of clinical trials to establish strong evidence and incorporate it into qualified and safe care for newborns.

Keywords: Infant, Newborn; Central Venous Catheters; Patient Safety; Technology.

RESUMO

Objetivo: identificar as evidências científicas acerca da técnica de Seldinger na inserção de cateteres venosos centrais em Neonatologia. Método: revisão integrativa nas bases de dados SCOPUS, MEDLINE, Web of Science, Science Direct, Alliance For Vascular Access Teaching and Research e em citações de interesse. Realizada no mês de dezembro de 2020, sem delimitação temporal. Resultados: foram encontrados 804 artigos. Destes, 18 foram incluídos. As publicações compreenderam o período de 1982 a 2016. Predominaram estudos internacionais, com níveis de evidência pouco robustos, desenvolvidos por médicos anestesistas e cirurgiões. A técnica de Seldinger foi considerada um método assertivo que garante mínima incidência de complicações e oferece segurança ao paciente. Além disso, é menos estressante comparada à punção direta. Conclusão: é uma tecnologia que carece de ampliação do número de pesquisas clínicas para estabelecer fortes evidências e incorporação na assistência qualificada e segura aos recém-nascidos.

Palavras-chave: Recém-nascido; Cateteres Venosos Centrais; Segurança do Paciente; Tecnologia.

RESUMEN

Objetivo: identificar evidencias científicas sobre la técnica Seldinger en la inserción de catéteres venosos centrales en Neonatología. Método: revisión integrativa en bases de datos y citas de interés SCOPUS, MEDLINE, Web of Science, Science Direct, Alliance for Vascular Access Teaching and Research. Realizada en diciembre de 2020, sin marco temporal. Resultados: Se encontraron 804 artículos. De estos, se incluyeron 18. Las publicaciones cubrieron el período de 1982 a 2016. Predominaron los estudios internacionales, con bajos niveles de evidencia, desarrollados por anestesiólogos y cirujanos. La técnica Seldinger fue considerada un método asertivo que garantiza una mínima incidencia de complicaciones y ofrece seguridad al paciente. Además, es menos estresante en comparación con la punción directa. Conclusión: es una tecnología que necesita ampliar el número de ensayos clínicos para establecer evidencia sólida e incorporación a la atención calificada y segura del recién nacido.

Palabras clave: Recién nacido; Catéteres Venosos Centrales; Seguridad del Paciente; Tecnología.

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INTRODUCTION

Hospitalized neonates often require prolonged venous access for drug administration and parenteral nutrition. Peripheral venous catheters (PVC) are recommended in this clientele if intravenous therapy is prescribed for up to seven days and if the drug allows administration in the peripheral route.[1] The umbilical catheter is considered the first choice in Neonatology for the installation of a central venous catheter (CVC), but which also has limitations, and should be replaced by another type of CVC if infusion therapy exceeds seven days.[2]

The use of peripherally inserted central catheters (PICC) is frequent in neonatal intensive care units (NICU) in term and premature newborns (NBs) receiving intravenous therapy with vesicant and irritant drugs.[3] In addition, depending on the caliber, they are also used for blood tests, transfusion of blood products, and hemodynamic monitoring.[4,5] Preterm infants generally have low birth weight and many are dependent on drugs that must be administered through long-term venous access.[4] Therefore, the PICC in the NICU has become it is essential in neonatal clinical practice.[3] It is a procedure in which nurses have become the professionals most involved in its execution[6], while surgical CVCs are inserted, privately, by physicians. In Pediatrics, the choice of which CVC to use is multifactorial and considers, in addition to patient and device characteristics, inserting technologies.[1]

It is widely recognized that CVC placement in NBs presents a unique set of technical challenges, therefore tools that can increase catheterization success are priceless.[7]

A technique that revolutionized access to the venous network in critically ill patients, known as Seldinger, has been around since the 1950s, when a radiologist came up with the idea of using a guidewire after needle puncture to guide the catheter into the blood vessel.[8] With technological refinements, the technique has evolved remarkably, resulting in less invasiveness in the insertion of central lines. After these increments, the Seldinger technique was also modified to serve patients who demand more delicate care, such as NBs. Both the surgical CVC and the PICC can be inserted using this technique, but phlebotomy and traditional percutaneous catheterization still prevail in many NICUs.

The National Association of Neonatal Nurses recommends the Seldinger technique in neonatal patients due to the difficulty of venous catheterization in this clientele.[9] The Infusion Nurses Society recommends using the safest insertion method available, including the Seldinger technique and its variations for placement of CVC in order to reduce the risk of insertion-related complications.[10]

As Moureau[11] points out, the advantages provided by the Seldinger technique should be explored both by Medicine and by Nursing, and they also describe that the use of this technology is the "new wave" for nurses. In this context, the need for national scientific productions that present this technology as an innovative, safe, and effective puncture method to reduce complications in an extremely vulnerable population, unlike any other age group, emerges. In this sense, the objective was to identify the scientific evidence about the Seldinger technique in the insertion of CVC in Neonatology.

METHOD

This is an integrative literature review, conducted according to the recommended steps: definition of the guiding question, literature search, data collection, critical analysis of selected studies, presentation of results and discussion of the integrative review.[12]

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[13] checklist was used to organize the information. The first step was characterized by the definition of the guiding question: "what is the scientific evidence related to the Seldinger technique for central venous catheterization in neonatology?". To this end, we used the PICO strategy (acronym for Patient, Intervention, Comparison and Outcomes), a useful tool to formulate a focused clinical question and generate appropriate search terms to find the best evidence.[14]

Thus, the search for articles was organized as follows: P – newborn; I - Sellinger technique; C – not applicable; O – does not apply. The descriptors and Boolean operators "OR" and "AND" vertically were used, resulting in the final research strategy "newborn AND 'Seldinger technique'". The search order was newborn OR neonates AND "central venous catheterization" AND "modified Seldinger technique" AND "complications" AND "microintroducer"; newborn AND "central venous catheterization" AND "modified Seldinger technique"; newborn AND "Seldinger technique"; newborn AND "Seldinger technique". The terms used are registered in the Health Sciences Descriptors (DeCS).

As study search strategies, the following databases were consulted: SciVerse Scopus, Medical Literature Analysis and Retrieval System Online (MEDLINE) via PubMed®, Web of Science (WoS), Science Direct and

Alliance for Vascular Access Teaching and Research (AVATAR), in December 2020.

From the process of identifying the studies in the databases, the search resulted in 683 articles. This step was carried out by two researchers with training and experience in Neonatology, in a standardized way and performed separately, with subsequent comparison of these results using an instrument developed by the researchers themselves. Studies whose titles or abstracts mentioned the Seldinger technique in Neonatology were obtained in full and then analyzed.

The inclusion criteria applied were primary and/or secondary documents published in any language; available in full online; are related to the insertion of CVC by the Seldinger technique in NBs. Temporal inclusion criteria was not established in order to find the largest number of searches due to the scarcity of literature.

Studies describing the Seldinger technique associated with ultrasound were excluded, since the combination of these two technologies is a very recent practice in neonatal intensive care units in Brazil. Studies that did not report the Seldinger technique alone as an insertion method were discarded.

The selection of articles was performed by two reviewers independently and took place in the respective order: after the search (n=683), the duplicated documents (n=28) were excluded, and the remaining articles (n=655) were selected by reading title and abstract. At this step, 612 articles were excluded because the Seldinger technique is not a technology used only for the insertion of venous catheters, but is also used in other areas of Medicine, such as Cardiology, Pneumology and Urology. Thus, 43 articles became eligible for full reading. After reading these documents in full, six citations of interest were found in the bibliographic references, which were also included in those eligible for full reading (n=49). After applying the eligibility criteria, 18 studies made up the research corpus.

At SciVerse Scopus, 51 documents were found, of which 16 met the criteria. At Science Direct, the search totaled 344 articles, of which only two were included. In the MEDLINE, WoS and AVATAR databases, the search totaled 43, 11 and 234 results, respectively, however, no article met the eligibility criteria.

In this study, the 18 selected articles were read in full and organized into the following topics: year of publication, level of evidence, country of origin, main results and conclusion of studies using the Seldinger technique. The levels of evidence[15] were established as follows: level I – at least one systematic review of multiple well-designed randomized controlled studies; level II – at least one well-designed, randomized, controlled clinical trial; level III – well-designed clinical trial, without randomization, of studies with only one group of the before and after type, cohort, time series or case-control studies; level IV – non-experimental studies by more than one center or research group; level V - opinions of respected authorities, based on clinical evidence, descriptive studies or expert committee reports.

RESULTS

From a total of 683 documents found, 18 met the criteria and were selected to compose this work. The flowchart with the steps of the study inclusion process is illustrated in Figure 1. The first research[16] dates from 1982 and the last[17] was published in 2016. Regarding the method, 15 were sectional, with only one cohort developed in the Netherlands[18], in 2015, which evaluated the reduction of infection in neonates, and a letter to the editor[19] reporting the safety of using the Seldinger technique in femoral catheterization in extreme preterm infants. As for the country of origin of the surveys, four were carried out in the United States; two in India, Brazil, Australia, Spain, Netherlands, and Germany; one in England and Denmark.

All articles included in this study presented results regarding the use of the Seldinger technique in Neonatology, addressing the advantages and disadvantages of this technology, the assertiveness of the method and complications inherent to its use.

Thirteen studies dealt with central venous catheterizations performed by medical professionals, nine using traditional CVCs and four PICCs. Only three studies featured the insertion of PICCs by nurses and one described that this procedure was performed by nurses under the direct supervision of a radiologist.[17]

Among the 18 studies included in this review, 10 evaluated the Seldinger technique in mixed pediatric populations, ranging from NBs to adolescents under the age of 18 years. The maintenance of these articles in the sample was justified so that more evidence could be found, as only eight publications made reference to the implementation of the technology exclusively in NBs.

Among the two selected national research, the one published in 2012[20] can be considered a national landmark on the subject of research, as it was the first Brazilian study to assess the effectiveness of the Seldinger technique in the pediatric population. In addition, there was only one publication that actually contextualized the comparison between the

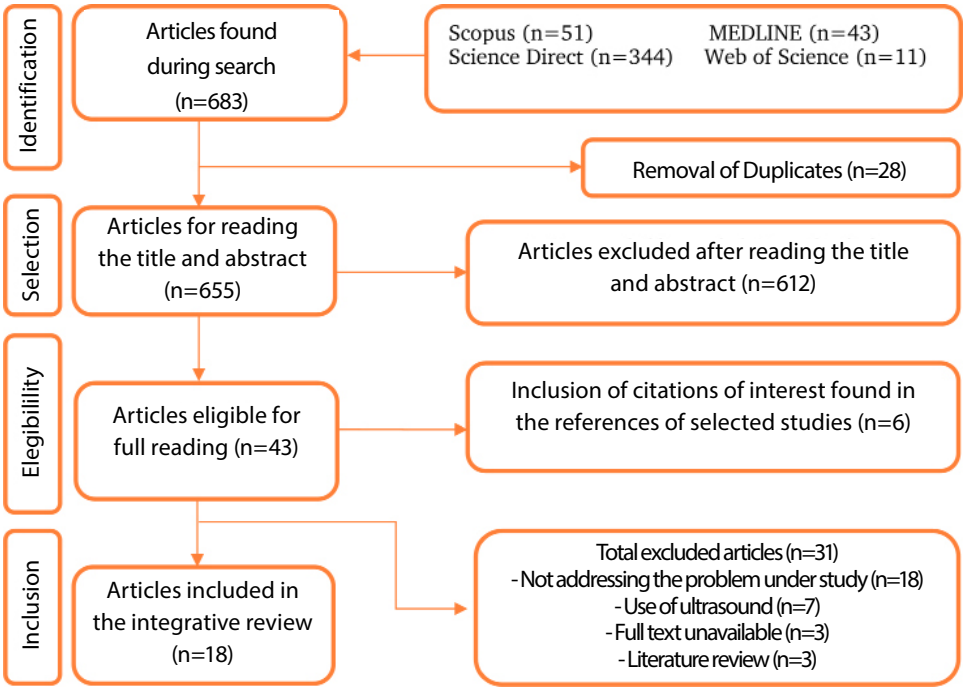

Figure 1 - Flowchart of identification, selection, eligibility, and inclusion of studies in the integrative review
Source: elaborated by the authors.

two CVC insertion techniques in Pediatrics, that is, the traditional catheterization versus the Seldinger technique.[18] Figure 2 shows the characteristics of each study regarding the year of publication, level of evidence, country of origin, main results and conclusion of the studies using the Seldinger technique.

DISCUSSION

Although the traditional method of central venous catheterization still has a prominent place in care, the Seldinger technique has numerous advantages for neonatal patients, whether for the insertion of surgical CVCs or PICCs. As much as these inserting technologies coexist, it is already recognized that the Seldinger technique has achieved notoriety for making the procedure minimally invasive in the neonatal population.[34]

It was highlighted that the methods of the articles selected for the review had low levels of evidence. No systematic review or randomized clinical trial on the isolated use of the Seldinger technique in NBs was found. Regarding the places where the research was carried out, international studies predominated.

Regarding professionals performing the Seldinger technique in NBs, there was a predominance of physicians. Originally, this technology was developed by a radiologist and first spread in Medicine, revolutionizing access to the venous network in such a way that it was extrapolated to other areas of the class, such as the placement of pleural and pericardial drains. Therefore, the insertion of percutaneous venous catheters by nurses using the Seldinger technique still needs to be expanded.

One of the main benefits of the Seldinger technique in Neonatology is the placement of larger caliber catheters than the introducer used for the puncture, a possibility that does not exist in the conventional technique, in which the introducer is always larger than the caliber of the device. Such specificity becomes very relevant in premature NBs, when high infusion rates are required. In this clientele, the smallest catheters available on the market are usually inserted (1 French), due to the fineness of the venous network. However, these very small devices are not suitable for high flow rates and, since there is a need for higher infusion rates, a 2 French catheter is more suitable, but much more difficult to place if not inserted using the Seldinger technique.[2]

As it is unlikely to have a compatible diameter between catheter/vein in extremely preterm infants, few studies in newborns weighing less than 1,500 grams have been published. Retrospective analysis evaluated the safety and feasibility of the Seldinger technique in preterm NBs weighing less than 1,500 grams with a mean gestational age of 26 weeks. The authors demonstrated that catheters with a caliber of 3 to 4 French were placed in these NBs without complications during their insertion and maintenance.[2] Pediatricians have consistently demonstrated the feasibility of central venous

Figure 2 - Characteristics of the studies in terms of year of publication, level of evidence, country of origin, results, and conclusions

Yesar/Evidence	Country	Results/Completion of studies using ST*
1982/IV[16]	Australia	Provided reliable venous access
1985/IV[21]	Denmark	Safe and reliable method in NB and children
1988/IV[22]	United States	Alternative, fast, assertive method with minimal complications
1992/IV[23]	Germany	It has become a routine procedure, improvements in catheters and insertion techniques
1995/IV[24]	Netherlands	Resulted in optimal placement of CVCs
1999/IV[25]	Spain	Careful procedure, experience, and proper material selection help keep the risk of complications low
2001/IV[26]	England	Low risk of complications in experienced hands
2003/IV[27]	United States	New technologies and the identification of favorable outcomes for patients should be a formal but simple process.
2006/IV[28]	Brazil	Evidenced the improvement in the quality of pediatric care
2008/IV[29]	Spain	Double lumen CVC in extreme preterm infants is possible and safe, even weighing less than 1,000 grams
2008/IV[30]	Germany	2 and 3 French catheters can be inserted more safely in neonatal and pediatric patients
2009/V[19]	India	Increases the security and assertiveness of the procedure
2011/IV[31]	India	Complications were lower with increasing familiarity with the procedure
2012/IV[20]	Brazil	Catheterization was performed safely and with a high success rate
2013/IV[32]	United States	It was indicated by nurses as a standard procedure
2015/III[18]	Netherlands	Low-cost care reduced infections in catheters inserted with the technique
2015/IV[33]	Australia	Insertion of the femoral CVC provides immediate alternative central venous access in critically ill NB
2016/IV[17]	United States	The two insertion techniques investigated had similar complication rates

CVC: central venous catheter; NB: newborn; NICU: neonatal intensive care unit; ST: Seldinger technique.
Source: elaborated by the authors.

catheterization with 3 to 4 French devices in premature neonates.[35] Retrospective study with NBs weighing between 485 and 1,390 grams described the placement of PICC gauges of 1.9 and 2.6 French without complications. Positioning was successful in all patients and a single episode of deep vein thrombosis was observed after catheter removal.[7]

Choosing the Seldinger technique for venous catheterization may favor the reduction of bloodstream infection associated with the catheter. Authors corroborate this statement when they describe that the risk of thrombosis and infection is lower when professionals are qualified to perform catheterizations with this technique.[9] The National Association of Neonatal Nurses defends the use of microintroduction in Neonatology due to its effective cost and its potential to reduce infections related to venous devices.[36]

Another complication that can be alleviated with microintroduction is bleeding. By the conventional method, larger gauge needles are used, causing an increase in the continuity lesion in the skin and, consequently, active bleeding, often with difficult hemostasis. One of the international recommendations to mitigate this complication is the use of the Seldinger technique.[9]

When reporting some important practical advice on managing complications in the insertion of CVC in Neonatology using the Seldinger technique, authors considered this method less stressful for NBs and for health professionals. Furthermore, they scored the following advantages over other techniques: it reduces venous trauma and procedure time and increases assertiveness in the first attempt. Another benefit is the possibility of exchanging the catheter in use for a new device, using the same vein and dispensing with a new puncture, when complications arise with the current catheter, such as bloodstream infection.[34]

American researchers described the improvement process adopted by an infusion therapy team in a community hospital, started in a neonatal intensive care unit. Nurses who implanted CVC at the bedside using the Seldinger technique began to demonstrate better patient outcomes and success rates. The evolution of products and techniques has greatly reduced the complications associated with CVC placement and improved results and patient satisfaction.[37] In addition to providing a successful and less traumatic experience for the NB, the incorporation of the Seldinger technique into clinical practice directly impacts the performing professional's time and the reduction of catheterization costs.[38]

Despite having appeared over 70 years ago, Seldinger's technique has become more widespread and applied in Medicine. Its use by nurses for the implementation of PICC dates back to 2007, when a neonatologist nurse incorporated the technology for this purpose in NBs.[39] In view of this, it is suggested that nurses, within the scope of their institutional competencies and limitations, should assess the effectiveness of this

technique through well-designed studies to produce robust scientific evidence. In addition, incorporating technology into their reality, contributing to the reduction of complication rates, and promoting the safety of the NB in infusion therapy.

The limitations of the present study were related to the scarcity of literature on the Seldinger technique in Neonatology. The deployment of this technology is relatively new to this clientele. In addition, most articles were written by anesthesiologists and surgeons, indicating that the insertion technique is rarely performed by nurses, especially in the Brazilian context.

CONCLUSION

Scientific evidence reveals that, in Neonatology, there is a lack of expansion in the number of clinical research about this technology to establish strong evidence and incorporation in qualified and safe care for newborns. The methods of the articles selected for the review showed low levels of evidence.

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