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Main Advantages of the PICC in Relation to CVC in Critically Ill Adult Patients: A Literature Review

Angélica Be Caballero[2], Maribel May Tamayo[2], Roberto Rodríguez López[2], Saúl May Uitz[1]* and Eloísa Beatriz del Socorro Puch Ku[1]

[1]*Profesor de carrera. Universidad Autónoma de Yucatán. México*

[2]*Estudiante de Enfermería de la Especialidad en Enfermería en Terapia Intensiva. Universidad Autónoma de Yucatán. México*

***Corresponding author:** Saúl May Uitz, Profesor de carrera. Universidad Autónoma de Yucatán. México.

Email ID: saul.may@correo.uady.mx

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ABSTRACT

Objective: To describe the advantages of installing the Central Venous Peripheral Insertion Catheter (PICC) and the Central Venous Catheter (CVC) in critically ill adult patients.

Material and Methods: Quantitative research, bibliographic review type. Question structured in PICO format, from which terms were identified and translated into controlled language through DeCS and MeSH as a search strategy, Boleanan operators AND and OR were used, to form search strings free terms were also considered; the sources consulted were PubMed, Science Direct, Journal of Patient Safety and BMC.

Results: A total of 272 articles were found, after the application of eligibility criteria, 244 were eliminated for not having relevant information, 3 did not have translation, 5 for excluded records, the remaining 20 articles were submitted to the Critical Reading Cards (FCL) instrument version 3.0, of which 13 were hierarchized by the SIGN scale. assigning a level of evidence based on the design and degree of recommendation. Thus, 7.69% (1) corresponds to a systematic review study, 61.53% (8) to cohort studies and 30.76% (4) to a case series.

Conclusion: The PICC demonstrated greater advantages compared to the CVC, making it a safe and efficient device, so it can be chosen as the first choice to have central vascular access in critically ill adult patients, highlighting that the installation carried out by trained nursing professionals contributes to the reduction of risks in its use.

Keywords: Patients; Adult; Critical Condition; Central Venous Catheters; Use of Procedures and Techniques

Abbreviations: PICC: Central Venous Catheter of Peripheral Insertion; CVC: Central Venous Catheter; PICO: Patient, Intervention, Comparison, Outcome; FLC: Critical Reading Sheets; RHOVE: Hospital Epidemiological Surveillance Network; HRAEPY: Regional High Specialty Hospital of the Yucatan Peninsula; UVEH: Hospital Epidemiological Surveillance Unit; UMAE: High Specialty Medical Units; DeCS: Descriptors in Health Sciences: MeSH: Medical Subject Headings; SING: Scottish Intercollegiate Guidelines Network; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; ULVT: Venous Thrombosis of the Upper Limbs; CKD: Chronic Kidney Disease; UEDVT: Deep Vein Thrombosis of the Upper Extremities

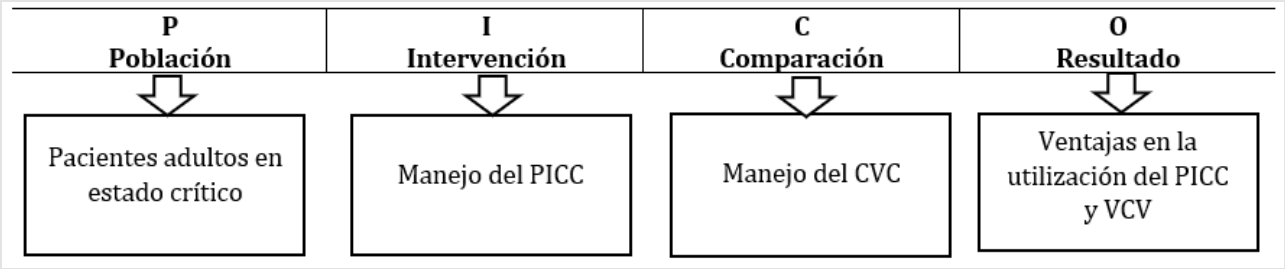
Introduction

Central venous catheters are devices that enable access to the bloodstream at the central level, they are used for therapeutic purposes for the infusion of fluids, the administration of pharmacological agents, transfusions, parenteral nutrition and hemodynamic monitoring. These devices provide a critical pathway for critical, chronic, and oncological patients by allowing a vein to be cannulated using a large-caliber catheter [1]. Various types of vascular catheters are available, characterized by variations in their material, caliber, length, number of lumens, as well as in the methods of insertion and localization. Among the most frequently used catheters, the Central Venous Catheter (CVC) stands out, which is a long, soft plastic tube, predominantly made of silicone. The insertion of this device is carried out in anatomical regions such as the collarbone, neck and/or groin. The CVC is introduced into a vein of considerable caliber, such as the subclavian, jugular and/or femoral vein, and then advances to the superior vena cava and the entrance to the right atrium [2,3]. On the other hand, the Peripherally Inserted Central Catheter (PICC) is an extensive and flexible non-tunneled peripheral and percutaneous insertion device. This catheter is positioned in a vein located in the upper portion of the arm, specifically through the basilica, cephalic and brachial vein, with its final trajectory to the superior vena cava [4]. It is imperative to address catheter-related complications, which can be classified into two categories: infectious and non-infectious; the latter divided into mechanical and non-mechanical. Infectious diseases include catheter colonization, insertion site infection, tunnel infection, and catheter-related bacteremia. On the other hand, non-mechanical complications include: venous thrombosis and catheter obstruction, while mechanical complications include: pneumothorax, arterial cannulation, malposition, and vessel perforation [5]. With the above, it is evident that complications in the environment of an Intensive Care Unit acquire significant relevance. Given the diversity in the previously mentioned characteristics, these eventualities can lead to a sub-optimal use of available resources, generating concomitant damage to the health of patients [6].

By way of illustration, it has been documented that in the United States about 5 million CVCs are placed per year, they have frequent complications, mainly mechanical and infectious, these occur in 5 to 19% [7].At national level, the Directorate-General for Epidemiology, through the Hospital Epidemiological Surveillance Network (RHOVE), reports an incidence of bacteraemia associated with the installation of vascular catheters. This complication, being an adverse of considerable magnitude, is directly associated with the comprehensive care of critically ill patients, manifesting a substantial impact in terms of morbidity, mortality, and costs associated with medical care [8]. Now, in the state of Yucatan; the Regional High Specialty Hospital of the Yucatan Peninsula (HRAEPY), in its system for the prevention and control of high specialty nosocomial infections in 2017, reported a frequency of infections detected in the adult intensive care service with a total of 41 cases. The Hospital Epidemiological Surveillance Unit (UVEH) of the HRAEPY reported a total of 8 infections due to bacteremia associated with venous catheters and 10,468 day-stays, generating a rate of 1.0 and 0.8 respectively [9]. In the High Specialty Medical Units (UMAE) in the IMSS, 3,082 episodes of catheter-related bacteremia were reported from 2007 to 2011 [8]. Although there are different complications, it is interesting to note that there are some with higher incidences; then being able to describe them will give you a guideline to know them more deeply, and have an advantage since there are several articles about them [5,10,11]. This is how important it is to conduct a review of the literature to analyze the advantages associated with the use of CVCs and PICCs. Since, although both have the same purpose, it is of great value to make a comparison and take into account their differences in order to be able to execute concrete actions with the interventions on patients. In our country, it is the nursing staff who insert the PICC and are also responsible for the care and health education of the patient. This makes it necessary to develop protocols so that the care of the PICC is carried out optimally in all cases and, in addition, it is necessary for nursing professionals to update their knowledge regarding this device in order to provide quality health care to patients in critical condition [12]. The objective of this review was to describe the advantages of using the PICC peripherally inserted central catheter and the conventional central venous catheter (CVC) in the Adult Intensive Care Unit through a literature review.

Material and Methods

Research with a quantitative approach of the bibliographic review type, the structured question was formulated from the description of the problem in the clinical context of critical care, the doubts led to the formulation of various questions susceptible to answers, which allowed the identification of population, intervention, comparison and outcome variables, being eligible for the writing of the question in PICO format (See Figure 1). The clinical question was formulated in PICO format; the process of analysis and preparation of the search was carried out, which consisted of identifying and elaborating a table with words in free language according to each variable of the structured question, which was translated into indexed language through the Descriptor in Health Sciences (DeCS) [13] and the Medical Subject Headings (MeSH) [14]. in Spanish, English and Portuguese. (See Table 1)



Note: Source: Own elaboration Be, May, Rodríguez, Uitz, Puch

Figure 1: Variables of the structured question.

Table 1: Terms translated into indexed languages.

Language	Patient/Problem P	Intervention I	Comparison C	Result O
	Critically ill adult patients	Using PICC	Using CVCs	Advantages in use
Spanish	Patients* Adult* Critical status*		Central Venous Catheters*	Health Benefits* Use of Procedures and Techniques*
English	Patients*/** Adult*/** Critical** Critical illness*	Venous Catheterization, Peripheral**	Central Venous Catheters*/**	Benefit** Benefits, Health* Procedures and Techniques Utilization*
Portuguese	Patients* Adult* Terminal status*		Central Venous Catheters*	Insurance Benefits* Use of Procedures and Techniques*
Free Language		PICC***	CVC***	

Note: Source: Based on DeCS* term search, MeHS**, free language***

Search Protocol

The tracking team was made up of three expert reviewers in the clinical area and with simple and advanced search skills, the location of the evidence was carried out during the second half of 2023, in the months of September and October. During this period, comprehensive searches were carried out covering various sources of information, including: databases, electronic journals and search engines The tracking, location and initial selection of scientific articles was carried out independently by each of the three reviewers, in different sources, at different times and with different strategies to achieve exhaustiveness, the presence of two external reviewers (SMU and EBSPK) was considered, which ensured greater quality in the search process and avoided observer bias. Likewise, for the management of the evidence, a log was used to safeguard the data or characteristics of the location process. (See Table 2).

Table 2: Search Log Format.

Documentary source	Strategy	Filters used	
Location	Select	Year	Design
Reference	1		
	2		
	3		
URL/DOI	1		
	3		
	3		
Archiving stored in Folder	Article-PDF-1		
	Article-PDF-2		
	Article-PDF-3		

Source: Own elaboration Be, May, Rodríguez, Uitz, Puch

Search Strategy

To optimize crawling efficiency, search strings were implemented using Boolean operators, with "AND" and "OR" as fundamental connectors. The search string adopted was "picc AND cvc", "benefits cvc AND PICC", AND picc and "cvc OR picc". The documentary sources used for the location of evidence were both primary and secondary, Databases: PubMed; Lilacs; BioMed Central; Cochrane; Publishers: Sciencedirect; Dovepress. Electronic journals: SciELO; Journal of Patient Safety and search engine: Google Scholar For an accurate search and to avoid information noise, the following eligibility criteria were established: studies with meta-analysis designs, systematic review, cohort studies, integrative synthesis, case series and clinical practice guidelines; articles published in Spanish, English, Portuguese; which compared both interventions and studies carried out in the adult population. A total of 252 documents were retrieved after an effective search, a set of 20 articles was identified that were selected based on their titles and abstracts. These articles were subjected to a critical evaluation process through the Critical Reading Cards (FLC) platform in its version 3.0 [15], by B. C. A.; M.T.M. and R.L.R. (See Table 3). From this analysis, 13 articles that met the quality criteria were highlighted, whose designs are: systematic review with 7.69% [1], 61.53% [8]cohort studies and 30.76% [4] case series. The procedure for selecting and choosing articles is described in detail in the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flowchart (See Figure 2). Based on the synthesis of the evidence, the degree of recommendation for studies with quantitative analysis was hierarchized Scottish Intercollegiate Guidelines Network (SIGN), describes that the level of evidence for the analysis of articles with a retrospective cohort design has the grade of recommendation B that was based on a volume of scientific evidence composed of studies classified as 2++ and case series has an evaluation of 3 and degree of recommendation D respectively. (See Table 4) [16-28].

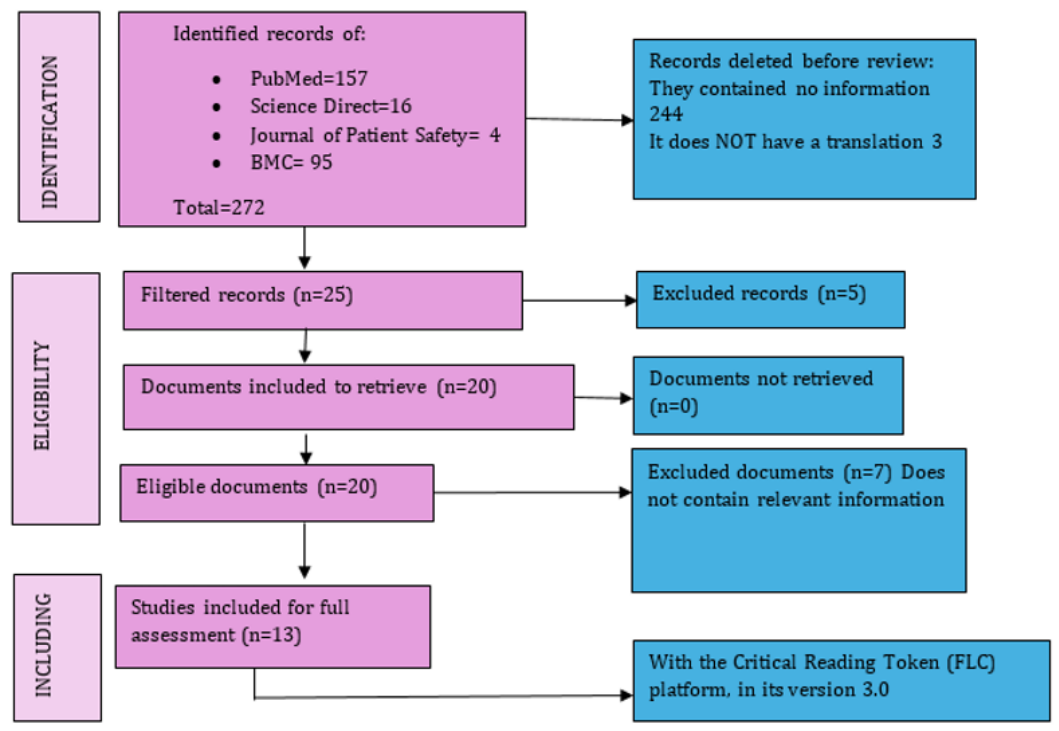


Figure 2: PRISMA Flowchart.

Table 3: Characteristics of localized studies.

Evidence	Fountain	Strategy	Design	Author/Year
Safe Central Venous Catheters for the Treatment of Esophageal Cancer [16]	PubMed	cvc AND picc	Retrospective Cohort	S Inoue2020
Comparison of microbial colonization rates between central venous catheters and peripherally inserted central catheters [17]	PubMed	cvc AND picc	Retrospective Cohort	V Pitiriga 2023
Role of peripherally inserted central venous catheters in the prevention of catheter-related bloodstream infections in patients with hematologic malignancies [18]	PubMed	cvc AND picc	Retrospective Cohort	T Sakai.2014
Study on the Effect of PICC on Parenteral Nutritional Support for Colorectal Cancer [19]	PubMed	cvc AND picc	Cohort	T Guo 2021
Catheter-related upper limb venous thrombosis in a tertiary hospital setting [20]	PubMed	cvc AND picc	Retrospective Cohort	Y Xuanye 2014
Cost-effectiveness analysis of peripherally inserted central catheters versus central venous catheters Catheters for hospital parenteral nutrition [21]	Journal of Patient Safety	cvc AND picc	Case Series	M Comas 2022
Peripherally inserted central catheters versus central venous catheters for intravenous access [22]	PubMed	cvc AND picc	Systematic Review	F Santos 2020
Predictable Risk Factors for Upper Extremity Deep Vein Thrombosis in a Level I Trauma Center [23]	Dovepress	cvc AND picc	Retrospective Cohort	S Tohme 2021
Central venous catheter insertion in patients with colorectal cancer, PICC or PC? [24]	Dovepress	AND picc	Case Series	L Yin 2020
Peripherally inserted central catheters have a protective role and the effect of the fluctuation curve on the risk of bloodstream infection compared to central venous catheters: a propensity-adjusted analysis [25]	BMC	cvc AND picc	Retrospective Cohort	Y Lv 2022
Lower risk of bloodstream infections with peripherally inserted central catheters compared to central venous catheters in critically ill patients [26]	BMC	picc OR cvc	Case Series	V Pitiriga 2022
To PICC or not to PICC? A Cross-Sectional Study of Vascular Access Practices in the ICU [27]	ScienceDirect	picc AND cvc	Case Series	S Govindan 2021
Safety of cryopreserved stem cell infusion through a peripherally inserted central venous catheter [28]	PubMed	cvc AND pic	Retrospective cohort	S Milczarek 2023

Source: Own elaboration Be, May, Rodríguez, Uitz, Puch.

Table 4: Synthesis and gradation of evidence according to SIGN.

Evidence	Design	Level of evidence	Degree of recommendation
Safe Central Venous Catheters for the Treatment of Esophageal Cancer [16]	Retrospective Cohort	2++	B
Comparison of microbial colonization rates between central venous catheters and peripherally inserted central catheters [17]	Cohort	2++	B
Role of peripherally inserted central venous catheters in the prevention of catheter-related bloodstream infections in patients with hematologic malignancies [18]	Retrospective Cohort	2++	B
Study on the Effect of PICC on Parenteral Nutritional Support for Colorectal Cancer [19]	Cohort	2++	B
Catheter-related upper limb venous thrombosis in a tertiary hospital setting [20]	Retrospective Cohort	2++	B
Cost-effectiveness analysis of peripherally inserted central catheters versus central venous catheters Catheters for hospital parenteral nutrition [21]	Case Series	3	D
Peripherally inserted central catheters versus central venous catheters for intravenous access [22]	Revision Systemic	2++	B
Predictable Risk Factors for Upper Extremity Deep Vein Thrombosis in a Level I Trauma Center [23]	Retrospective Cohort	2++	B
Central venous catheter insertion in patients with colorectal cancer, PICC or PC? [24]	Case Series	3	D
Peripherally inserted central catheters have a protective role and the effect of the fluctuation curve on the risk of bloodstream infection compared to central venous catheters: a propensity-adjusted analysis [25]	Retrospective Cohort	2++	B
Lower risk of bloodstream infections with peripherally inserted central catheters compared to central venous catheters in critically ill patients [26]	Case Series	3	D
To IPCC or not to PICC? A Cross-Sectional Study of Vascular Access Practices in the ICU [27]	Case Series	3	D
Safety of cryopreserved stem cell infusion through a peripherally inserted central venous catheter [28]	Retrospective Cohort	2++	B

Note: Source: Own elaboration Be, May, Rodríguez, Uitz, Puch

Results

The synthesis of the findings showed that the PICC offers greater safety and efficacy compared to CVCs, supported by a lower incidence of colonization, reduction of bacteremia when placed by specialized personnel, and evidence of a lower incidence of complications compared to CVCs. Comparisons of microbial colonization rates indicate that PICCs show a lower incidence of colonization despite a long dwell time compared to CVCs; these, when colonized, a high percentage of Gram-negative pathogens are observed, especially multidrug-resistant, which shows that PICC exhibits a protective function against bloodstream infections associated with the central line [16,17,21,25,26]. Thus, it is evident that the PICC, compared to the CVC, not only reduces costs by reducing hospital stay [16,19,21,24] but also suggests a lower rate of bacteremia when inserted by nursing personnel with experience in vascular access [16,27]. Likewise, the extended duration of the PICC, unlike the CVC, contributes to maintaining longer treatments, thus reducing the number of punctures and mitigating pain in critically ill patients [16,26]. This suggests that the PICC may be a more favorable option in terms of colonization and comfort for patients. Additionally, a highlight of the study is the safety of PICC in cancer treatments, neoplasms, stem cell administration and TPN administration, compared to CVC; based on findings based on decreased catheter-related complications, infusion safety, and decreased inflammatory factors [18,19,21,24,28]. These results support the feasibility and desirability of using the IPCC in this specific context.However, the possibility is raised that CVC is less associated with upper limb venous thrombosis (ULVT) and has a shorter detection time for coagulation. Importantly, however, the use of both PICC and CVC in patients with pre-existing diagnosis of hypertension and chronic kidney disease (CKD) presents independent risk factors for upper extremity deep vein thrombosis (UEDVT) [20,23]. These findings have significant implications for clinical practice, highlighting the importance of considering the intrinsic safety of vascular access devices. A comparison of both catheters was performed using bar graphs to evaluate the main complications and obtain the advantages (See Graphs 1 & 2).

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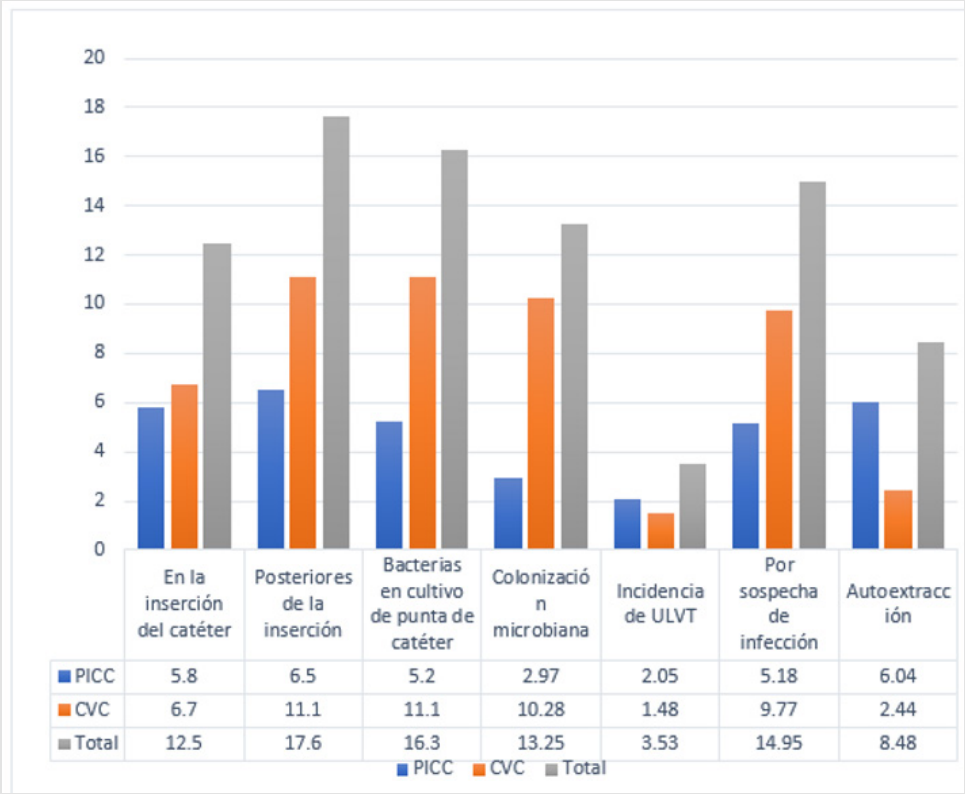
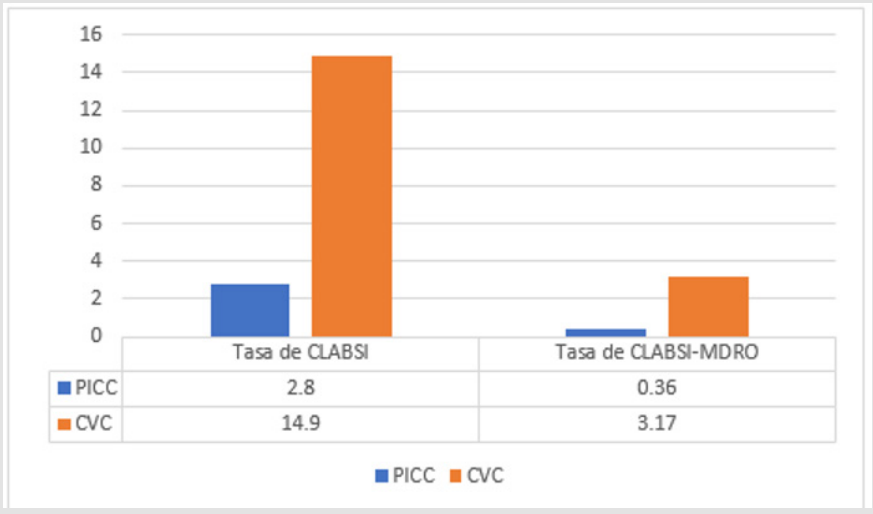


Source: Own elaboration Be, May, Rodríguez, Uitz, Puch
Note: Data extracted from the articles included in the study.
Graph 1: Incidence of complications.



Source: Own elaboration Be, May, Rodríguez, Uitz, Puch
Note: Data extracted from the articles included in the study.
Graph 2: Infection rate

Discussion

During the research, aspects related to complications during insertion were addressed, as well as those that occur in the post-installation period, including recurrent incidents. The most frequent results when comparing both devices include: complications associated with each device, thrombosis in large veins, bloodstream infections associated with central catheters and insertion trauma. In a study titled "A Randomized Trial of Peripheral and Central Insertion Central Line Complications in the Neuro Intensive Care Unit," published in 2019, Brandmeir notes similar findings [29]. This is consistent with the articles reviewed, as it incorporates all the previously mentioned components, which are essential to carry out a thorough analysis of both types of catheters. Similarly, it is explained that the devices used for central venous catheterization show particular advantages as well as their own complications; the choice of a central venous catheter should be individualized, taking into consideration the specific characteristics of each patient, the experience accumulated in a particular health care setting, as well as the accessibility and associated cost, a result similar to the position of the author Simon Turcotte in his study "Peripherally inserted central venous catheters are not superior to central venous catheters in the acute care of surgical patients in the ward" of the 2006, but it is contradictory to the author's conclusion that there is no clear evidence that the PICC is outstanding to CVC in intensive care settings[30] since it has been shown that the PICC offers greater advantages in critically ill patients. In relation to the formation of venous thrombi, the article agrees with the conclusions of Turcotte and Eva Johansson, who state that the Peripheral Central Access Intravenous Catheter (PICC) increases the risk of thrombotic complications [30,31] although it simultaneously reduces the probability of catheter occlusion. In contrast, the analysis differs from the perspective presented by Nanishi, who maintains that CVC has a significant incidence of deep vein thrombosis[32]. This study supports the short-term safety of PICCs; however, it is important to highlight the warnings that point out the potential risks of post-installation complications, compared to CVCs, whose complications tend to manifest themselves mainly at the time of installation. From the above, it was evidenced that the complications that are commonly associated with centrally inserted peripheral venous catheters include thrombosis, obstruction, infection and phlebitis. The mitigation of these risks could be achieved by carrying out the insertion and care of the PICCs by duly qualified nursing personnel, this is in line with the conclusion of María Martín in her article "Adverse events in the placement of PICCs" of 2021[33]. Finally, this article contributes to the comprehensive understanding of the advantages associated with the use of PICC and CVC, providing a critical view supported by the literature review, with significant clinical implications.

Conclusion

In conclusion, both devices offer different advantages, however, the peripherally inserted central venous catheter (PICC) demonstrated greater advantages compared to the CVC, because it is a safe and efficient device so it can be chosen as the device of first choice to have vascular access in critically ill adult patients. The advantages are demonstrated in the reduction of complications during and after insertion, as well as the reduction of infections to the bloodstream associated with the central line, a longer duration in catheter days, a decrease in hospital stay and as a result a reduction in costs. The evidence found highlights that the installation of the PICC can be carried out by trained nursing professionals; a crucial aspect that contributes to the reduction of risks linked to its use. This, in turn, facilitates planning in the provision of care, as well as in the operation and maintenance of the device. Consequently, it is necessary to provide training and coaching in technical skills to nursing staff operating in critical areas to achieve greater tangible advantages for patients. There were some limitations when searching for articles, because there is very little number of documents that study the comparison of both devices, there is very little high-quality evidence, most of the studies that exist did not compare both interventions.

Gratitude

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Conflict of Interest

In the context of this literature review, it is important to highlight the absence of conflicts of interest on the part of the authors.

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For the preparation of this scientific article, there was no resource to carry out the research

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