

Prevention of Blood Flow Infections Associated with the Central Venous Catheter: Systematic Review

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Abstract:- Prevention is based on better control and care of central venous catheter-associated bloodstream infections by establishing a theoretical foundation with a scientific basis that contributes to nursing practice worldwide. Objective: To review the scientific evidence on the prevention of central venous catheter-associated bloodstream infections. Methodology: A bibliographic review of original articles with relevant information on prevention was carried out through the following search engines: PubMed, Scielo, Redalyc and Medigraphic, maximum of 5 years, in Spanish and English. Results: A total of 8181 were obtained, as a result of selection 20 high impact articles were included whose main variables were related to the prevention of bloodstream infections that are associated with central venous catheter. Conclusions: Associated risk factors and prevention methods were evidenced that, from nursing practice, can be applied to avoid complications, existing preventions such as the proper use of medical equipment and the respective sterilization of the instruments to be used, in addition to frequent hand washing of personnel, can avoid infections of bacteria such as coagulase staphylococcus, staphylococcus epidermidis, enterococcus, staphylococcus aureus and candida.

Keywords:- Infections, Prevention, Catheter, Bacteria, Mortality.

I. INTRODUCTION

Prevention is based on better control and care of bloodstream infections associated with central venous catheters through structural changes in the performance of state institutions and health care homes. When interventions are not carried out correctly, these problems arise and consequently infections, it is necessary to establish and ensure compliance with measures to modify the behavior of the health care team, In medical care homes, whether they are health centers or hospitals, there is an increase in the number of cases of bloodstream infections due to central venous catheters, related to risk factors such as the length of stay and the site of insertion of the central venous catheter, hospital stay, exposure to parenteral nutrition according to days of treatment, management of the device, and lack of prevention (1).

In medical practice, prevention in the use of central venous catheters is of transcendental importance, in order to avoid infections that can worsen the patient's situation; The use of the catheter, which is currently associated with most procedures, has many causes that lead to infections, one of them being bacteremia, which causes infections in the central catheter, among them we also have the time the catheter remains in place, inadequate handling, poor aseptic technique during placement, administration of parenteral nutrition, administration of hemoderivatives, facts that already constitute a social problem and need to be studied to prevent complications and bloodstream infections associated with the use of the central venous catheter that is currently generating a morbid rate and mortality (2).

The World Health Organization as an international control organism, based on records, indicates that there are thousands of patients admitted to the intensive care unit with central venous catheters, which produce around 80,000 bacteremias in patients with central catheters, resulting in around 28,000 deaths each year (3).

The central venous catheter is classified by type according to its anatomical situation in terms of thoracic and jugular, inguinal, abdominal, peripheral access; also, in terms of its duration which can be short, medium, long; by the number of lumens which are unilumen, bilumen, traumen, quadrilumen and five lumens and by the implantation techniques in which they are non-tunneled, tunneled, internal implantation; by approach, external, internal (4).

The peripheral venous catheter is a catheter that is inserted into the forearm veins; infectious complications are rare and potentially serious (5).

The non-tunneled central venous catheter is one of the most commonly used catheters for temporary treatments, this catheter can have one or several lights; as for the existing infection risks, this catheter causes 90% of the bacteremias associated with vascular catheters (6).

Central venous catheters

There are three types of central venous catheters: tunneled catheter, implanted port and peripheral introduction; the tunneled catheter is introduced into a neck or chest vein passing under the skin leaving one end of the catheter outside the skin in order to deliver medication, this type of catheter due to its location makes it less visible and allows the patient to move with greater flexibility (7).

The implanted port catheter has a similarity with the tunneled catheter, however the fact that differentiates them is that this catheter remains under the skin covered by the skin in its entirety, the medication is delivered by this catheter which is located under the skin; this type of catheter contains a reservoir through which the medication is constantly emanating into the bloodstream (7).

The peripheral insertion catheter is totally different from the tunneled and implanted port catheter, which, unlike the latter, is not implanted in the neck or chest but in a vein in the arm (8).

Bacteria from central venous catheter bloodstream

Enterobacteriaceae. - These are bacteria that systemically and locally produce complications in the bloodstream associated with the central venous catheter, thus producing septic thrombophlebitis, endocarditis, metastatic complications, pulmonary and cerebral abscesses, as well as ophthalmitis.

Staphylococcus aureus. - It is an anaerobic bacterium that causes infections resulting from the application of the venous catheter, this bacterium is spread using an object that is infected, in bacteria that are dispersed by sneezing or coughing, this bacterium tends to travel through the bloodstream causing endocarditis and osteomyelitis (9).

The prognostic assessment of the severity of bacteremia is related to some social aspects, among which the main aspect is age; studies carried out in Europe establish that older adults are the most affected by infections derived from the use of the central venous catheter to the bloodstream; bacteremia can be both in-hospital and out-of-hospital; For the treatment of bacteremia it is essential to analyze the risk according to age, the existing asepsis index for the application of the central venous catheter, baseline characteristics that will allow us to define the risk of infections and the most appropriate treatment to be used for the treatment of bloodstream infections associated with the central venous catheter (10). In the case of catastrophic diseases, the challenges for the prevention of infectious diseases derived from the application of the central catheter are even greater, in extracorporeal blood circuits they are performed in hemodialysis, plasma exchange and for monitoring and hemodynamic interventions in central venous pressure, central oxygen saturation, pulmonary artery pressure, temporary transvenous pacing, frequent sampling, temperature monitoring (12,13).

Immediate and late complications of central venous catheter-associated bloodstream infections.

As for complications, these can be either immediate or delayed; among the immediate complications are (14,15,16,17):

Mechanical: Arterial puncture, arterial catheter placement, bleeding, pneumothorax, hemothorax, arrhythmia, thoracic duct injury, cardiac tamponade.

Thrombotic: air embolism, guidewire embolism.

Similarly for late complications we have:

Mechanical: cardiac tamponade, vessel erosion or perforation, venous stenosis, embolism or catheter rupture.

Thromboembolic: catheter-related thrombosis, pulmonary embolism, air embolism.

Infectious: Colonization of the catheter, catheter-related bloodstream infection.

There are several factors that give rise to these infections, the mechanisms for infection to occur in intravascular catheters are extraluminal route in which microorganisms migrate from the external surface insertion site to the tip, extraluminal route originating inside the catheter by manipulation of the connections or by administering contaminated solutions.

The replacement of a CVC origin of an infection, through a guidewire system, has a high risk of recurrence and possible embolization, so its routine practice is contraindicated; in the case of the indwelling central venous catheter there is an antagonism because the need for which the catheter was placed with an infection puts the patient at total risk and even more with the change of the catheter that in certain cases, given the evolution of the microorganisms that generate infections, the removal of the catheter is of total importance (18).

The thrombogenic capacity of catheters and their composition influence the capacity to develop infections; certain microorganisms, especially staphylococci and Candida, have a greater capacity to adhere to polyvinyl catheters than to those made of Teflon, There are three focal types through which infection-causing microorganisms can gain access, among them, 20 contamination at the time of infusion, contamination at the time of connection and contamination of the skin at the time of insertion, factors for which rigorous sterilization control of medical material is the primary source of prevention (19).

When an obstruction has occurred, it is advisable to remove the catheter. On some occasions when clot formation is suspected to be very recent, gentle aspiration with a syringe should be attempted. If the clot is successfully removed, the maintenance of patency should then be checked, otherwise the catheter should be removed; in no case, in the presence of an obstruction, should the catheter be flushed by exerting positive pressure with a syringe to unblock the catheter, since this would introduce the thrombus into the patient's bloodstream and this could have serious health consequences (20).

II. METHODOLOGY

Type of Research

The present study is a systematic review of cross-sectional type that was carried out from the bibliographic and documentary deepening that began with a search strategy to determine the inclusion and exclusion criteria, as well as the health descriptors specified through the keywords used in the search through the respective databases.

Inclusion criteria

- Randomized descriptive, clinical, and cross-sectional studies.
- Studies that are linked to the key words.
- That the main study variables are related to central venous catheter-associated bloodstream infections.
- Studies in Spanish and English.
- That they are no older than 6 years (2015-2021).

Exclusion criteria

- Descriptive studies or systematic reviews.
- Studies prior to 2015.
- Studies that do not coincide with the research variables.
- Studies in a language other than English or Spanish.

Bibliographic search

For this case, the following keywords were initially established: Infections, Catheter, Prevention, Bacteria, Mortality. The search was carried out through the following search engines: Scielo, Redalyc, PubMed and Medigraphic.

Procedure

The development of the study was carried out in phases. In the first phase, the topic was identified and the scientific question that guided the development of the study

was formulated, which allowed establishing the research objectives: What are the measures for the prevention of bloodstream infections associated with central venous catheters, and what are the risk factors associated with bloodstream infections?

In the second phase, the search strategy was established, which included the inclusion and exclusion criteria, as well as the key words that led to the next phase, which involved the primary search for publications that met the established criteria, for which the following were reviewed: title of the article, year of publication, type of study and key words. Subsequently, the fourth phase consisted of a more in-depth review of the articles selected in the previous phase, for which the following were evaluated: the abstract, associated variables, results or findings. Finally, relevant information associated with the object of study of the present research was compiled, the results obtained were interpreted and the main dissertations of the subject of study were presented through discussion to finally draw conclusions.

III. RESULTS

The results of the systematic review of the publications that were consulted according to the search strategies applied are presented below, where a total of 8181 documents were initially found. After applying the inclusion and exclusion criteria, a total of 7669 articles remained, of which 30 resulting from the review of the association of key words and the abstracts were used for complete reading. Finally, a total of 20 studies were included in the final sample and are presented below according to the identification, selection, eligibility and inclusion phases required for this type of systematic review.

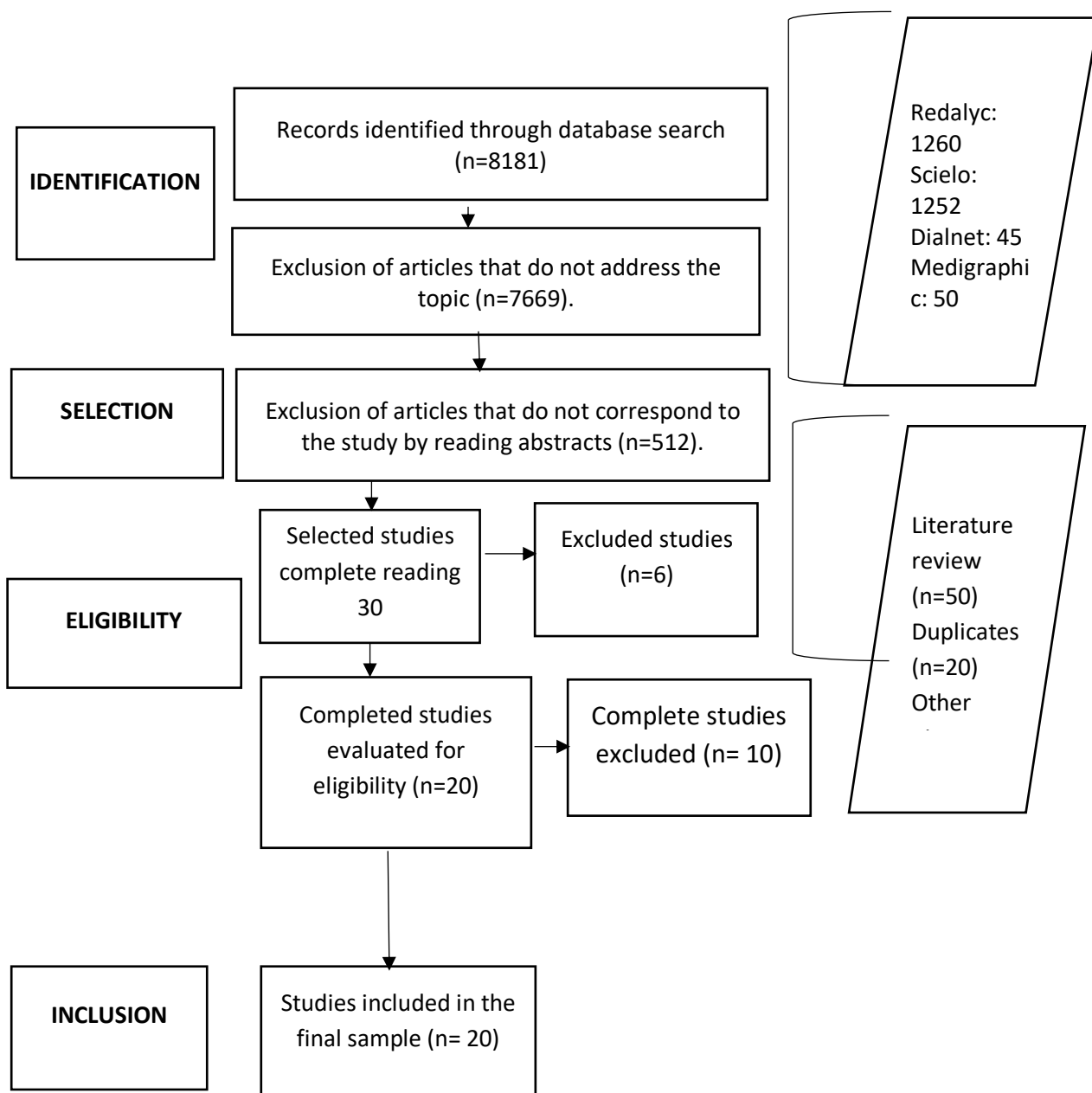


Figure 1 Search strategy.

N	YEAR	AUTHOR	TITLE	TYPE OF STUDY	ASSOCIATED KEYWORDS	ASSOCIATED VARIABLES				RESULTS FINDINGS AND CONCLUSIONS
						RISK FACTORS	INFECTION	TYPE OF CARE	PREVENTIVE MEASURES	
1	2015	Arias J	Central venous catheter-associated bloodstream infections in the intensive care service.	Quantitative study.	Central venous catheter, septicemia	Bacteria-dependent factors	yes	Bundes, which have shown excellent results	Daily monitoring of the devices	Out of 20 studies identified on the prevention of septicemia infections associated with central venous catheters, 6 are aware of the problem.
2	2016	Bernardi C	Central venous catheter complications in patients transplanted with hematopoietic stem cells in a specialized service.	Retrospective, quantitative study.	Central venous catheter, adverse effects	Insertion site and duration time	yes	Antibiotic	Adequate conditioning of the catheter prior to insertion.	The majority of patients used the Hickman catheter with a mean stay of 47.6 days. The complication fever/bacteremia
3	2015	Castellanos J	Central venous catheter-associated infections in patients on total parenteral nutrition.	Retrospective, observational study.	Central venous catheter, Bacteremia, infection	Bacteremia-dependent factors	yes	Profil axis antibiotic	Adequate protocol	In critical patients, where a zero-bacteremia protocol was followed, there were no cases of infection. In the rest of the patients, the bacteremia rate was 13.10 per 1,000 days of CVC.
4	2016	Callegaro G	Evidence of care for prevention of central venous catheter-related bloodstream infection.	Systematic Study	Infections, central venous catheter, central venous catheter, intensive therapy	Type of catheter and insertion site	yes		Education and commitment of the team and the institution	Maintenance and Insertion Care, as well as Team Education and Institutional Interventions
5	2018	Carrillo I	Chronic Disease Oriented Health Services.	Retrospective, systematic, narrative study.	Citizen participation, patient anticipation, health policy				Health training	There is moderate evidence that citizen participation legitimizes the decisions of health authorities.
6	2015	Chacón E	Bacteremia/fungemia associated with peripherally inserted central venous catheter.	Retrospective study.	venous catheter, peripheral insertion, fungemia	Bacteremia Dependent Factors	yes	Profil axis a antibiotic	Improve the venous catheter insertion process and training.	163 cases of procedure-associated bloodstream infection were identified. One patient had two infections by different microorganisms in two CCIPs.
7	2016	Chincha O	In-hospital infections associated with invasive devices in intensive care units.	Observational study	Hospital infection, incidence, intensive care	Bacteremia-dependent factors	yes	Antibiotics	Sterilization measures should be implemented	The main infectious agents isolated were Pseudomona sp. (32.3%) in the emergency ICU, coagulase-negative Staphylococcus (36%) in the medical ICU and Candida sp (69.2%) in the surgical ICU.
8	2015	García F	Infections associated with central venous catheters in the pediatric intensive care unit.	Observational study	Central venous catheter, infections, pediatric intensive care	Bacteremia-dependent factors	yes	Antibiotic	Maintenance of a continuous educational activity of physicians and nurses.	The majority of CVC-related infections are caused by coagulase-negative Staphylococcus (38%).
9	2015	Giseli J	Evaluation of neonatal and pediatric mortality related to central venous catheter	Systematic review study	Mortality, catheter-related infections, mortality				Proper catheter insertion and maintenance practices	From the studies found, it was verified that primary sepsis was the main complication related to the use of the

			use.							central venous catheter, and the most prevalent microorganisms in these infections were <i>Candida</i> sp and <i>Staphylococcus</i> sp.
10	2015	Guajardo C	Bacteremia associated with central venous catheter, Revista Médica del Instituto Mexicano del Seguro Social.	Retrospective study	Hospital-acquired infections, catheter-related infections, bacteremia	Bacteremia-dependent factors	yes	Profilaxis antibiotic	Monitoring of catheter insertion	A total of 176 laboratory proven BACVC were identified, which represented 11% of the IIHs, occupying third place in frequency.
11	2015	Kabalan P	Central Venous Catheter Infections and Lock Therapy in Oncologic Patients.	Descriptive study	Central venous catheter, therapy	Bacteremia-dependent factors	yes	Antibiotic	Systemic monitoring after catheter insertion	The most frequently isolated microorganism was coagulase-negative <i>Staphylococcus</i> . CVC preservation was achieved in 7 patients.
12	2015	Londoño A	Epidemiology of central venous catheter-associated infection.	Retrospective study	Bacteremia, infections	Bacteremia Dependent Factors	yes	Antibiotic	Maintenance of a continuous educational activity of doctors and nurses.	Incidence of bloodstream infection was 11%, incidence density 9/1000 days/catheter; surgery was identified as a risk factor (RR 4.2 CI95% 1.5-11.7).
13	2015	Manzanaras A	Central venous catheter-associated infections in patients with total parenteral nutrition.	Retrospective study	Total parenteral nutrition, central venous catheter, bacteremia, infection	Bacteremia-dependent factors	yes	Antibiotic	Health training	A total of 176 CVC in 159 patients were analyzed. In 47% of the cannulations the access route was the jugular vein, despite being a location with a higher risk of infection.
14	2017	Nakachi G	Decreasing Central Venous Catheter-Associated Infections through Simple Interventions	Observational and longitudinal study	Catheter-related infections, hospital infection,	Bacteremia Dependent Factors			Maintenance of a continuous educational activity of doctors and nurses	A total of 1,047 patients with CVCs were monitored for 9,303 days of CVC exposure; 60 had CVC-associated STIs, with an average annual incidence rate of 6.03 (10.01, 5.33, 3.28 and 5.49, respectively per year).
15	2016	Osuna A	Factors Influencing the Development of Central Venous Catheter-Related Infection and Related Germs	Descriptive study	Infections, hospital infection, critical care	Bacteremia factors	yes	Antibiotic	Control of catheter insertion	117 catheter tip cultures were reviewed, of which 38 (32.5%) showed bacterial growth and 79 (67.5%) did not.
16	2018	Parra M	Incidence of central venous catheter associated infection and risk factors	Observational study	Catheter, infection, sepsis	Insertion site and duration time	yes	Profilaxis antibiotic	Adequate catheter insertion protocol	Eighty-five files were reviewed; 52% were women and 48% were men. The mean age was 54 years. The most frequent diagnosis was entero cutaneous fistula. Infection developed in 19% of the patients.
17	2020	Quirós G	Central venous catheter and its complications	Retrospective study	Bacteremia, infections	Bacteremia-dependent factors	yes	Antibiotic	Improved venous catheter insertion process and training	CVC placement has now become a useful intervention in the management of in-hospital patients; due to the different associated complications, it is essential that these are known to the medical staff.

18	2020	Suarez C	Risk Factors	Observational, analytical study	Infection, health care, central venous access	Insertion site and duration time	yes	Prophylaxis antibiotic	Implementation of catheter sterilization and medical care measures	A total of 102 patients were studied, most of them between 50 and 69 years of age and predominantly male. Arterial hypertension and diabetes mellitus were the most reported antecedents.
19	2016	Valencia L	Clinical-epidemiological characteristics of patients with central venous catheter-associated infection.	Retrospective, analytical study	central venous catheterization; hospital-associated infection, hospital infection, risk factors	Bacteremia factors	yes	Antibiotic	Adequate catheter insertion protocol	Central venous catheter infection was diagnosed in 17 patients, with a median age of 68 (RIC=55-68) years. They were 64.7% male.
20	2015	Vergara T	Cost study of central venous catheter-associated bloodstream infections in adult patients.	Observational study	vascular catheter-associated infections, cost analysis, bacteremia	Bacteremia factors	yes	Antibiotic	Daily monitoring of the devices allows to control and therefore to apply preventive measures at the right time	Ten cases of STI/CVC were evaluated with their respective controls. The mean additional hospital stay was 20.3 days per patient (40 vs 20.3 days; p < 0.05), antimicrobial consumption was higher in cases (median DDD 36 vs 10.5; p < 0.05) and there was a trend towards a higher number of cultures per patient (9 vs 5; p: 0.057).

Table 1. Tables of selected articles .

IV. DISCUSSION

Bloodstream bacteremias are a serious and frequent complication among infections related to vascular devices, the minimum recommended waiting time between catheter insertion and the start of conditioning treatment should be planned with the team, as well as not extending the period of catheter permanence and performing continuous training, focusing on the prevention of complications. Infections related to central venous catheter (CVC) use are complications with a high prevalence and potentially serious consequences (7,8,9,17).

The challenges for the prevention of hospital central venous catheter-associated bloodstream infections have increased, due to the variety of microorganisms, often multidrug-resistant, involving the use of broad-spectrum antimicrobials; citizen participation in health policies is expected to lead to greater acceptability of health plans and actions and the achievement of better results in terms of equity, acceptability, and efficiency (18,20).

Bloodstream infections are one of the serious complications that can occur in hospitalized patients; there are various risk factors associated with them, the most important of which include the use of invasive medical devices for central or peripheral venous catheterization; central venous catheter-associated bacteremia (CVCB) is

one of the most frequent hospital-acquired infections (HCAI); given its severity and mortality, it is considered a benchmark in the quality of medical care (17,18,19).

Central catheters are devices that allow access to the bloodstream for diagnostic, therapeutic and monitoring purposes; complications due to their use include those associated with their insertion, breakage or displacement of the catheter, or even thrombosis and infection, the latter increasing morbidity and mortality, and the use of parenteral nutrition increases the risk.²⁰

V. CONCLUSION

The use of central venous catheters in clinical practice has emerged as an option for vascular access in patients with prolonged hospital stays for various pathologies, a catheter is an access to the bloodstream at the central level, for the administration of drugs among other functions, the implementation and subsequent generalization of central venous catheters, produces an exponential increase in infectious complications; and it has been shown that relaxation in asepsis increases the number of infections.

Of the 20 studies identified on the prevention of septicemia infections associated with central venous catheters, only 6 are aware of the problem, multidimensional interventions that addressed care with maintenance and

insertion, as well as team education and institutional interventions; there is moderate evidence that citizen participation legitimizes the decisions of the health authorities and that it improves the results of public policies.

The main infectious agents isolated were pseudomonas (32.3%) in the emergency ICU, coagulase-negative Staphylococcus (36%) in the medical ICU and candida (69.2%) in the surgical ICU; the rates of infections associated with invasive devices were reported to be high similar to other national hospitals with limited resources and infrastructure, 1. Of the studies found, it was verified that primary sepsis was the main complication related to the use of central venous catheters, with Staphylococcus being the most prevalent microorganisms in these infections.

Likewise, the study shows that in addition to the existing causes of bacteremia with the presence of Staphylococcus as the main cause of bacteremia, there are prevention factors that should be used by medical and nursing staff, hygiene by health professionals in the pre and post catheter insertion care as well as the use of prevention techniques will greatly help to avoid complications and bloodstream infections associated with the central venous catheter.

In this order of ideas, it is concluded that from the nursing practice, the evaluation and assessment that the professional performs on the patient's characteristics in relation to the capacity that may manifest for the insertion of the catheter helps to prevent bloodstream infections and edema, allows to determine the type of treatment required and to guarantee in some way its adherence.

For this reason, it is advisable to use methods such as education and commitment of the team and the institution, health training, improvement of the venous catheter insertion process and training, maintenance of a continuous educational activity of doctors and nurses, adequate practices in catheter insertion and maintenance, systemic control after catheter insertion, daily follow-up of the devices allows control and therefore the application of preventive measures at the appropriate time.

REFERENCES

- [1]. Arias J, Central venous catheter-associated bloodstream infections in the intensive care service. *Rev Costa Rica*; 2012 [cited March 24, 2021] 78 (2) 1-9. Available from: <https://www.redalyc.org/pdf/448/44824928007.pdf>
- [2]. Bernardi C, Central venous catheter complications in patients transplanted with hematopoietic stem cells in a specialized service, *Rev. Latino-Am. Enfermagem*; 2016 [cited 2021 Mar 25] 56 (3) 267-387. Available from: https://www.scielo.br/scielo.php?pid=S0104-11692016000100331&script=sci_arttext&tlng=es
- [3]. Castellanos J, Central venous catheter-related infections in patients with total parenteral nutrition. *Rev Madrid*; 2012 [cited March 25, 2021] 32 (9) 775-780. Available from: <https://www.redalyc.org/pdf/3092/309226788023.pdf>
- [4]. Callegaro G, Evidence of care for prevention of central venous catheter-related bloodstream infection. *Rev. Latino-Am. Enfermagem*; 2016 [cited 2021 Mar 25] 67 (6) 248-278. Available from: https://www.scielo.br/pdf/rlae/v24/es_0104-1169-rlae-24-02787.pdf
- [5]. Carrillo I, Health Services Oriented to Chronic Diseases. *Rev Chile*; 2018 [cited 2021 Mar 26] 42 (5) 123-156. Available from: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1137-66272018000100091
- [6]. Chacón E, Bacteremia/fungemia associated with peripherally inserted central venous catheter, *Rev. Chile. Infectol*; 2011 [cited Mar 25, 2021] 28 (4): 382-385. Available from: https://scielo.conicyt.cl/scielo.php?script=sci_arttext&pid=S0716-10182011000500017
- [7]. Chíncha O, In-hospital infections associated with invasive devices in intensive care units. *Rev Peru*; 2013 [cited March 26, 2021] 30 (4) 616-620. Available from: <https://www.redalyc.org/pdf/363/36329481012.pdf>
- [8]. Garcia F, Infections associated with central venous catheters in the pediatric intensive care unit, *Rev. Colombia. Medicine*; 2010 [cited Mar 27, 2021] 84 (9): 77-84. Available from: <https://www.redalyc.org/pdf/2611/261120994008.pdf>
- [9]. Giseli J, Evaluation of neonatal and infant mortality related to central venous catheter use. *Rev Colombia*; 2012 [cited March 31, 2021] 25 (3) 90-95. Available in: https://www.scielo.br/scielo.php?script=sci_abstract&pid=S0103-21002012000100016&lng=en&nrm=iso&tlng=es
- [10]. Guajardo C, Bacteremia associated with central venous catheter, *Revista Médica del Instituto Mexicano del Seguro Social. Rev. Médica del Instituto Mexicano del Seguro Social*; 2010 [cited 2021 Mar 18] 78 (6) 145-150. Available from: <https://www.redalyc.org/pdf/4577/457745507006.pdf>
- [11]. Kaban P, Central Venous Catheter Infections and Lock Therapy in Oncologic Patients, *Rev Chile Pediatr*; 2010 [cited 20 March 20, 2021] 81 (5): 425-431. Available from: https://scielo.conicyt.cl/scielo.php?script=sci_arttext&pid=S0370-41062010000500006
- [12]. Londoño A, Epidemiology of central venous catheter-associated infection, *Rev Chile Pediatr*; 2011 [cited March 21, 2021] 82 (6) 493-501. Available from: https://scielo.conicyt.cl/scielo.php?pid=S0370-41062011000600003&script=sci_arttext&tlng=en

- [13]. Manzanares A, Central venous catheter-associated infections in patients with total parenteral nutrition, *Rev Spain Hosp*; 2012 [cited 2021 Mar 26] 76 (8) 109-356. Available from: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S0212-16112012000300014
- [14]. Nakachi G, Decreasing central venous catheter-associated infections through simple, low-cost interventions in a pediatric intensive care unit, *Rev. Peru. Med*; 2017 [cited Mar 28, 2021] 78 (2) 167-189. Available from: http://www.scielo.org.pe/scielo.php?script=sci_arttext&pid=S1025-55832017000300009
- [15]. Osuna A, Factors influencing the development of central venous catheter-related infection and related germs. *Rev Mexico*; 2010 [cited March 29, 2021] 97 (8) 871-877. Available from: <https://www.redalyc.org/pdf/487/48715008004.pdf>
- [16]. Parra M, Incidence of central venous catheter-associated infection and risk factors. *Rev Mexico*; 2017 [cited March 30, 2021] 85 (4) 104-108. Available from: <https://www.redalyc.org/pdf/662/66250058002>
- [17]. Quirós G, Central venous catheter and its complications, *Rev Costa Rica*; 2020 [cited March 30, 2021] 37 (4) 278-365. Available from: https://www.scielo.sa.cr/scielo.php?script=sci_arttext&pid=S1409-00152020000100074
- [18]. Suarez. C, Risk factors, *Rev. Madrid*; 2017 2020 [cited 2021 March 31] 26 (9) 36-47. Available from: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1729-519X2018000200018
- [19]. Valencia. L, Clinical-epidemiological characteristics of patients with central venous catheter-associated infection, *Rev. Colombia*; 2016 [cited April 1, 2021] 52 (7) 78-36. Available from: <https://www.redalyc.org/pdf/1590/159026906008.pdf>
- [20]. Vergara T, Cost study of central vascular catheter-associated bloodstream infections in adult patients, *Rev. Chile*; 2015 [cited April 1, 2021] 32 (6) 456-489. Available from: https://scielo.conicyt.cl/scielo.php?script=sci_arttext&pid=S0716-10182015000700004