INFECTIOUS COMPLICATIONS ASSOCIATED WITH THE TOTALLY IMPLANTABLE CENTRAL VENOUS CATHETER

COMPLICAÇÕES INFECCIOSAS ASSOCIADAS AO CATETER VENOSO CENTRAL TOTALMENTE IMPLANTÁVEL

COMPLICACIONES INFECCIOSAS ASOCIADAS AL CATEGOR VENOSO CENTRAL TOTALMENTE IMPLANTABLE

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ABSTRACT

Objective: to seek scientific evidence on infectious complications associated with the use of a fully implantable central venous catheter in adult oncology patients. **Method:** integrative review, in which selection criteria and controlled descriptors were used, through the PICO strategy, to search for indexed articles in the Lilacs and Medline databases, from 2012 to 2017. A data collection instrument was used which covered: research topic, general objective, methodological characteristics, sample / population, intervention, control, results, conclusions and level of evidence. **Results:** 12 articles were included, which indicate that catheter-related infection, bloodstream infection and subcutaneous pouch infection were the most prevalent, and the microorganisms *Staphylococcus aureus* and *Candida spp*, the most common in the etiology. **Conclusion:** there was little scientific production about the research topic, with studies with a low level of evidence and absence of national publications, which demonstrates the need to deepen the thematic in the country through studies with strong methods for the significant evidence in the use of fully implantable central venous catheters. **Descriptors:** Nursing; Central Venous Catheterization; Catheter-Related Infections; Review.

RESUMO

Objetivo: buscar evidências científicas sobre complicações infecciosas associadas ao uso do cateter venoso central totalmente implantável em pacientes oncológicos adultos. **Método:** revisão integrativa, na qual se utilizaram critérios de seleção e descritores controlados, por meio da estratégia PICO, para a busca de artigos indexados nas bases de dados Lilacs e Medline, no período de 2012 a 2017. Foi empregado instrumento de coleta de dados que abrangeu: tema de pesquisa, objetivo geral, características metodológicas, amostra/população, intervenção, controle, resultados, conclusões e nível de evidência. **Resultados:** incluíram-se 12 artigos, os quais apontam que a infecção relacionada ao cateter, infecção da corrente sanguínea e a infecção da bolsa subcutânea foram as mais prevalentes, e os microrganismos *Staphylococcus aureus* e *Candida spp*, os mais comuns na etiologia. **Conclusão:** evidenciou-se escassa produção científica acerca da temática pesquisada, encontrando-se estudos com baixo nível de evidência e ausência de publicações nacionais, o que demonstra a necessidade de aprofundamento da temática no país por meio de estudos com métodos fortes para o levantamento de evidências significativas na utilização dos cateteres venosos centrais totalmente implantáveis. **Descritores:** Enfermagem; Cateterismo Venoso Central; Infecções Relacionadas a Cateter; Revisão.

RESUMEN

Objetivo: buscar evidencias científicas sobre complicaciones infecciosas asociadas al uso del catéter venoso central totalmente implantable en pacientes oncológicos adultos. **Método:** revisión integrativa, en la cual se utilizaron criterios de selección y descriptores controlados, por medio de la estrategia PICO, para la búsqueda de artículos indexados en las bases de datos Lilacs y Medline, en el período de 2012 a 2017. Fue empleado instrumento de recolección de datos que abarcó: tema de investigación, objetivo general, características metodológicas, muestra / población, intervención, control, resultados, conclusiones y nivel de evidencia. **Resultados:** se incluyeron 12 artículos, los cuales apuntan que la infección relacionada al catéter, infección del flujo sanguíneo y la infección de la bolsa subcutánea fueron las más prevalentes, y los microorganismos *Staphylococcus aureus* y *Candida spp*, los más comunes en la etiología. **Conclusión:** se evidenció escasa producción científica acerca de la temática investigada, encontrándose estudios con bajo nivel de evidencia y ausencia de publicaciones nacionales, lo que demuestra la necesidad de profundizar la temática en el país por medio de estudios con métodos fuertes para el levantamiento de evidencias significativas en la utilización de los catéteres venosos centrales totalmente implantables. **Descriptores:** Enfermería; Cateterismo Venoso Central; Infecciones Relacionadas con Catéteres; Revisión.

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INTRODUCTION

Among the categories of scientific articles that use sources of bibliographic or electronic information to obtain research results from other authors are the articles of Integrative Review (IR). IR is a type of literature review that gathers findings from studies developed through different methodologies, allowing reviewers to synthesize results without hurting the epistemological affiliation of the included empirical studies.¹

IR, as a systematization of scientific knowledge, is increasingly approaching the Evidence-Based Practice (EBP), since the value of scientific evidence must be demonstrated for all healthcare staff when it is intended to favor professional practice. The results have increasingly benefited Nursing care, recognizing that the combination of research methods, although under different epistemological matrices, improves integration with clinical practice.¹

The studies based on clinical practices that aim to improve the quality of care in Nursing need to be encouraged, highlighting in this review the research on infectious complications associated with the use of Central Venous Catheter (CVC) in the population of adult oncology patients, more specifically the Totally Implantable Catheter (TIC).

ICU is a long-term catheter option that allows the infusion of chemotherapeutic agents, solutions, blood transfusions, nutrition and collection of exams safely. ² It is emphasized that the use of intravenous devices, such as ICU, has the potential of complications to the patient, which may be associated with morbidity and mortality, especially during hospitalization.

Such complications are classified as early and late. The early ones usually occur between 48 hours and seven days after the implantation of the catheter. Late infections occur later in this period.³ In this context, infection is a late complication that can be caused by the use of contaminated material, contamination of the catheter connections or from the colonization of the skin⁴, besides being responsible for the discontinuity treatment, antimicrobial resistance of immunosuppressed patients and increased mortality.⁵

OBJECTIVE

- Finding scientific evidence on infectious complications associated with the use of a

fully implantable central venous catheter in adult oncology patients.

METHOD

It is an integrative review, which allows the formulation of general conclusions about a certain area of study, through the synthesis of multiple published studies. It is developed in six phases, namely: definition of the research question; delimitation of inclusion and exclusion criteria; data search; analysis of data and results; interpretation of the results and synthesis of the review.⁶ In order to answer the research question: "What scientific evidences are found in the publications about the infectious complications associated with the use of the fully implantable catheter in adult oncology patients?" the search for articles in the Latin American and Caribbean Literature on Health Sciences (LILACS) and Medical Literature Analysis and Retrieval System Online (Medline) databases, in May 2017. The articles were selected using descriptor indices (DECS), through the BIREME interface, and subject descriptors of the Medical Subject Heading (MeSH), by the US National Library of Medicine (NLM).

The selection of the articles obeyed the strategy PICO7, being the descriptors thus selected: P - Adult OR Young adult; I - Central Venous Catheters OR Central Venous Catheterization; C - does not apply; O - Infection OR Catheter - Related Infection. In both databases, the groups of descriptors were crossed, according to Boolean logic, with 'P' AND 'I' AND 'O'.

The articles found were selected after reading the title and summary and subsequent application of the inclusion criteria: articles published between January 2012 and May 2017; available online for free; in Portuguese, English or Spanish; related to one of the infectious complications associated with the use of Totally Implantable Catheter in cancer patients. As exclusion criteria, publications related to Totally Implantable Catheters that did not meet the proposed theme, as well as those referring to pediatric patients, were disregarded.

The search in the LILACS database totaled 141 articles, proceeding with the reading of all titles. Of these, 28 were selected to read abstracts, of which 24 were excluded because they did not meet the inclusion criteria, making a total of four articles selected.

In the search conducted in the Medline database, 200 articles were obtained, with the reading of all titles. Of these, 62 abstracts

were read, with the selection of eight studies for inclusion.

The selected articles were read in full, using a data collection instrument that included information related to article identification, research theme, general objective, methodological characteristics, sample / population, constitution of the intervention and control groups, results,

conclusions and level of evidence for the analysis of methodological rigor.

The evidences are classified in degrees of force, according to the characteristics of the sources in which they were generated. According to the research design, it is possible to rank them in a hierarchical scale of degrees (Figure 1).

Level of evidence	Description of evidence
I	Strong evidence of at least a systematic review (meta-analysis) of all relevant randomized controlled trials, well outlined or derived from clinical guidelines based on systematic reviews of randomized controlled trials.
II	Strong evidence from at least one randomized controlled trial, well outlined, of adequate size and with appropriate clinical context.
III	Evidence obtained from well outlined clinical trials without randomization.
IV	Evidence from well-delineated cohort and case-control studies or studies of only one before and after type group.
V	Evidence from a systematic review of descriptive and qualitative studies.
VI	Evidence derived from a single descriptive or qualitative study.
VII	Evidence from the opinion of authorities and / or expert committee reports

Figure 1. Levels of evidence. Curitiba (PR), Brazil, 2017.

Source: adapted from Melnyk BM, Fineout-Overholt E, 2005.⁸

The strategies of discussion and interpretation of the results, as well as the synthesis of extracted data, are presented in a descriptive way.

RESULTS

The final sample consisted of 12 articles, one from the year 2016; three of the year 2015; four, from 2014; two, 2013 and two,

2012, all in the English language. In relation to the research design, we identified six retrospective studies, one cross-sectional study, one randomized clinical trial and four prospective observational studies. The characteristics of each study in relation to the research design, objective, database and level of evidence are highlighted in figure 2.

Reference, year of publication	Research design	Objective	Database	Level of evidence
9, 2015	Retrospective observational	To evaluate the technical success and complication rates of the radiological insertion of the fully implantable central venous accesses through the internal jugular vein.	Medline	VI
10, 2014	Retrospective observational	To evaluate the efficacy and safety of implantation of the fully implantable central venous catheter in the internal jugular vein guided by ultrasonography in patients with breast cancer.	Lilacs	VI
11, 2016	Retrospective observational	To determine whether insertion of fully implantable central venous catheters into the arm may be an option for chemotherapy treatment, in addition to catheters inserted into jugular and subclavian veins, in terms of catheter-related complications.	Medline	VI
12, 2012	Prospective observational	To evaluate the characteristics of fully implantable catheter-related infection in patients with malignant tumors using	Medline	VI

		microbiological evaluations.		
13, 2015	Retrospective Cohort	To analyze the incidence and risk factors for fully implantable central venous catheter-related infection among Chinese patients who received cytotoxic chemotherapy.	Medline	IV
14, 2014	Retrospective observational	To report the pattern of use and rate of complications of fully implantable central venous catheters in patients diagnosed with malignant cancer at a referral center.	Lilacs	VI
15, 2014	Retrospective Cohort	To examine the impact of long-term central venous catheter use on the risk of infection independent of other risk factors such as chemotherapy in a population of cancer patients.	Medline	IV
16, 2013	Prospective observational	To determine the incidence of complications and the patient's perception regarding fully implantable central venous access.	Lilacs	VI
17, 2012	Prospective observational	To assess the incidence of fully implantable catheter-related infections in patients with solid tumors, as well as risk factors for severe septicemia and septic shock, cancellation of antineoplastic chemotherapy, and death.	Medline	VI
18, 2014	Prospective observational	To evaluate the cases of Pantoea agglomerans contamination in the Oncological Service of the Iseo hospital (Brescia, Italy), after the patients presented septic fever after heparinization of the fully implantable central venous catheter.	Medline	VI
19, 2015	Cross sectional	Assess whether the body surface temperature near the central venous catheter insertion area is different when patients develop catheter-related bloodstream infections.	Medline	VI
20, 2013	Randomized Clinical Trial	To compare the use of saline versus heparin solution for blocking of fully implantable central venous accesses.	Lilacs	II

Figure 2. Characteristics of included studies according to study identification, year of publication, research design, objective, database and level of evidence. Curitiba (PR), Brazil, 2017.

The topic addressed, in relation to the objectives of the articles, presented variability. Two studies had the same variable of interest in relation to the analysis of the insertion of fully implantable catheters by the internal jugular vein and guided by imaging^{9,10} and two other studies compared the risk of infection associated with the use of the catheter in the arm.^{11,12} as well as the incidence of infectious complications that

affect the permanence and removal of the catheter.^{16,17} The other investigations were carried out among isolated cases of Pantoea agglomerans contamination¹⁸, assessment of the body temperature close to the insertion of the catheter suspected of infection¹⁹ and a single randomized clinical trial comparing two types of solutions for totally implantable catheter blockage.²⁰

It should be noted that the majority of the studies obtained a considerable and relevant number of participants (over 100), except for four studies that obtained reduced samples (n

= 7; 39; 59 and 72).^{12,17-9} The study, which (n = 1391).¹³ The data referring to the results and conclusions of the studies analyzed were compiled in figure 3.

Reference, publication	year	of	Results and conclusions
9,	2015		Fluoroscopic images, chest radiographs and medical records of 12547 totally implantable catheter punctures were analyzed in 1237 patients, with technical success achieved in 1253 deployments (99.9%). The mean age of the patients was 57 years and the length of the catheter was 350 days. The catheterization was performed predominantly through the right internal jugular vein (95.5%). In total, eight infectious complications occurred (0.64%), including sepsis, six febrile bacteremias and one infection of the subcutaneous pouch. With the exception of cases of febrile bacteremia treated with systemic antibiotics, the catheter was removed in all cases. The radiological placement of a fully implantable central venous catheter through the internal jugular vein is safe and efficient, as evidenced by the high technical success rate and low complication rate.
10,	2014		A total of 492 patients were evaluated. The mean age of participants was 48.66 years and there was female prevalence (n = 487). Of the 492 punctures performed in internal and subclavian jugular veins, the majority were internal jugular vein (n = 480, 97.56%). Complications were classified as early (referring to the first two weeks of catheter use) and late, with early infections being found in two patients (0.41%). Two types of late infections were found after three months of use of the catheter for infusion of chemotherapy and fluid administration: catheter-related infection (n = 4, 0.81%) and infection of the subcutaneous pouch (n = 3; 0 , 61%). The catheter was removed in four patients (0.83%) due to infection with penicillin-resistant Staphylococcus aureus bacteremia. The mean duration of the catheter was 359 days (minimum of 28 and maximum of 712 days). The study demonstrated that the use of an ultrasound-guided internal jugular vein puncture for fully implanted catheter insertion is feasible and safe in breast cancer patients because of the low rates of complications.
11,	2016		A total of 433 patients underwent implantation of the fully implantable central venous catheter in the dominant arm, except for patients with breast cancer and axillary lymph node dissection, which was implanted in the unaffected arm. In 98.6% of the patients, there were malignant tumors, with the three most common being colon cancer (54.3%), gastric cancer (10.4%) and breast cancer (10.4%). The accumulated time of catheter stay was 251,538 days, with an average duration of 439 days. A total of 43 cases of infection were found in patients who used the infusion of chemotherapy (9.9%, 0.17 / 1000 days of catheter), seven of which were positive for bacteria (1.6%, 0, 03/1000 days of catheter) and four for fungi (0.9%, 0.02 / 1000 days of catheter). The infection of the subcutaneous pouch occurred in 16 patients (3.7%, 0.064 / 1000 days of catheter), with catheter removal in ten cases. In the patients who used the catheter for fluid infusion, infection occurred in 44 patients, with catheter-related infection (6.2%) and subcutaneous pouch (3.6%). There was no significant difference in infection rates between the chemotherapy group and the group that used the catheter for fluid infusion. The study demonstrated that fully implantable central venous access, inserted in the arm, may be one of the options in patients with some difficulty accessing internal and subclavian jugular veins, with complication rates comparable to central catheters inserted in the thorax.
12,	2012		59 patients and 60 punctures were analyzed (one patient had two fully implantable catheters). There was a predominance of males (69.5%), with a mean age of 62 years. The catheter's residence time was 2038 per thousand catheters per day. Head and neck cancer had the highest incidence (61%). The technical success of the placement of the fully implantable central venous catheter was achieved in all patients, being subclavian (71.7%) and forearm (28.3%). The catheter-related infection after three months of implantation was observed in three patients (5.1%), all with head and neck cancer, and the infection of the subcutaneous catheter pocket was observed in one patient (1.7%) per Staphylococcus aureus and catheter-related bloodstream infection in three patients (3.4%) with methicillin-resistant Staphylococcus aureus. Prior to placement of the fully implantable catheter by the subclavian colon, there was colonization of the skin at the insertion site in ten patients, while no colonization was observed in patients with a catheter in the forearm. At one and four weeks, colonization detection rates were also higher in catheter patients in the subclavian. The study showed that colonization of the skin was more prominent in subclavian vein insertions than in the forearm region.
13,	2015		Of the 1391 patients evaluated, 62% were male and 38% female, with a mean age of 59.8 years. There were 1449 fully implantable catheter implants and 149 cases of infection. The length of stay was 16.6 months or 723,192 per 1000 day catheters, with an overall rate of infection of 0.21 per thousand catheters per day. Hematologic neoplasms and head and neck cancer were associated with an increased risk of catheter infection (p <0.001). For chemotherapy, defined as neoadjuvant, adjuvant and others, it was observed that patients on neoadjuvant chemotherapy had a higher risk of catheter-related infection than patients on

14, 2014	<p>adjuvant treatment (p <0.001). Gram-negative bacteria were the most common pathogens, with prevalence of <i>Pseudomonas aeruginosa</i> (15.4%) and <i>Enterobacteria</i> spp (12.7%). <i>Staphylococcus</i> spp was the most common gram-positive pathogen (14.7%). The isolated fungus included <i>Candida</i> spp (9.4%). The study concludes that it is necessary to implement safe measures to prevent infections related to the central venous catheter, especially in patients with hematologic cancer, as well as in patients receiving neoadjuvant chemotherapies.</p> <p>A total of 106 patients were analyzed, the majority being female (70.1%). The mean time of catheter stay was 354 days. Breast cancer was the most incident (44.2%). Infection was the most common complication (25.6%), leading to premature catheter removal, with <i>Staphylococcus aureus</i> being the most isolated microorganism (6.8%). The underlying diagnosis (p <0.001), chemotherapy regimen (p <0.001), and antibiotic sensitivity (p = 0.01) were all significant factors affecting the time of permanence of the fully implantable catheter.</p>
15, 2014	<p>Patients older than 65 years who used long-term central venous catheters of semi-implantable, fully implantable and peripheral insertion types were analyzed. Most of the central catheters were fully implantable (66% to 82% by type of cancer), with lung cancer being the highest incidence (56.7%), followed by breast cancer (42.2%), colorectal cancer (36.27%), non-Hodgkin's lymphoma (14.43%), pancreatic cancer (10.53%) and head and neck cancer (8.45%). The risk ratio for an adjusted model analysis has shown that pancreatic cancer patients who use long-term central venous catheters are three times more likely to develop infection. In patients with breast cancer, the risk increases sixfold. Patients with semi-implantable catheters and central peripheral insertion catheters had a higher proportion of documented infections than patients with fully implantable catheters (23% to 41%, 22% to 43%, 13% to 27%, respectively). The use of a long-term central venous catheter was associated with an increased risk of infection in the elderly with cancer.</p>
16, 2013	<p>A total of 249 patients were included in the study, with a mean age of 62 years and female prevalence (60%). The catheter's residence time was 37763 per thousand catheters per day. In 15 patients (6% or 0.39 / 1000 days of catheter), local infection occurred in the subcutaneous pouch, with coagulase-negative staphylococci (53%) and <i>Staphylococcus aureus</i> (26%) being the most common microorganisms. Infection of the catheter-related bloodstream was recorded on two occasions (0.8% or 0.05 / 1000 days of catheter). These patients had the catheter removed immediately and the infections were treated successfully with antibiotic therapy. Regarding the perception of the patients who used the catheter, 81% reported that the catheter facilitated their treatment and 73% had little or no effect on their daily lives. It is concluded that the use of the fully implantable catheter presents a low infection rate and a high degree of patient satisfaction.</p>
17, 2012	<p>The sample consisted of 72 patients, with a mean age of 60 years. Tumor of the pancreas was the most prevalent (25%). Most of the patients had fever (n = 55; 76%); 23 had local signs of infection (32%), including 14 local complications requiring removal of the catheter (13 subcutaneous pouch infections and a tunnel infection). Ten patients had severe sepsis (18%, 95% CI = 10-29) and three had septic shock. Four of these severe episodes were caused by coagulase-negative staphylococci (three <i>Staphylococcus epidermidis</i> and one non-characterized); three were due to <i>Candida</i> species. The incidence of complications was 18% for severe septicemia or septic shock (13/72 patients), 30% for definitive cancellation of antineoplastic chemotherapy (14/46 patients who still had active treatment) and 46% for death in the week (33/72 patients).</p>
18, 2014	<p>In the seven cases analyzed, five patients were female and two were male. The mean age was 67 years and in six cases the diagnosis was of colon adenocarcinoma. The patients presented septicemia after lavage of the catheter with saline solution or heparin. The mean duration of the catheter was 23.8 months, until the time of fever. In three cases, the fully implantable catheter was removed by indication of the oncologist. The bacterium <i>Pantoea agglomerans</i> was isolated at the tip of the catheter in one case and in the blood culture collected from the catheter in six cases. In all cases, peripheral blood cultures were negative and all affected patients were treated successfully.</p>
19, 2015	<p>Data were collected from 39 patients, 75% of patients hospitalized in a clinical unit and 25% in an Intensive Care Unit. The mean age was 57 years. 323 temperature measurements were taken at three consecutive moments: areas of catheter insertion, contralateral to the insertion region, and frontal face region. Measures were classified according to sex: 59% of measures for males and 41% for females. Regarding the type of catheter, 77% were of the non-tunneled type and 23% of the type totally implantable. Four patients, two of each sex, had six cases of catheter-related infection during the study (two patients had two cases), of which three had a fully implantable central venous catheter. The pathogens identified were <i>Acinetobacter junii</i>, Methicillin resistant <i>Staphylococcus aureus</i> and <i>Staphylococcus warneri</i>. The temperature of the catheter insertion area was higher in patients with bloodstream infection (p <0.01). The study demonstrated that using a non-contact infrared thermometer, patients with catheter-related bloodstream infections had higher temperature values around the catheter insertion area.</p>
20, 2013	<p>A total of 802 patients were included in the study. After randomization, 398 participants were allocated to the saline receiving group as a blockade, and 404 to the heparin solution receiving group. There was a prevalence of females in both</p>

groups (64.6% for the saline group and 66.1% for the heparin solution group). The overall mean age was 55 years. Most patients were affected by breast cancer (36% for the saline group and 35% for the heparin solution group). Catheter-related bloodstream infection was considered a secondary outcome and was present in two patients in the saline group (0.03 per 1000 days of catheter) and in six patients in the heparin solution group (0.10 per thousand days of catheter). In the heparin solution group, *Staphylococcus aureus* was present in two cases and *Staphylococcus epidermidis* in three cases. In the saline group, there were two cases of infection of the bloodstream, one for *Staphylococcus hominis* and one for *Staphylococcus epidermidis*. Saline is a safe and effective blocking solution for implantable central venous access if combined with a rigid protocol for insertion and maintenance of the device.

Figure 3. Synthesis of the included studies in relation to the main results and conclusions. Curitiba (PR), Brazil, 2017.

DISCUSSION

In the approach of articles that portrayed the issue of infection associated with the use of ITC, it was observed that the studies cited the problematic infection only as one of the complications related to the use of this type of catheter, without emphasizing its relevance, which corresponds to a limiting this study to the plurality of complications addressed in the articles analyzed.

Major venipuncture sites for the insertion of central venous catheters include the internal jugular veins and the subclavian veins. Other possible sites consider the cephalic vein, axillary vein and femoral vein.²¹ In two articles included in this study^{9,16}, the efficiency of the CTI insertion technique when guided by imaging and the rate of complications related to it was evaluated. Both performed essentially puncture by the internal jugular vein, and it was observed that this puncture site, associated with the image-guided technique, was safe and with a low rate of complication, including an early or late infection rate of less than or equal to 1%. Two other studies on site-related complications compared the internal and subclavian jugular veins with the catheter implant by the arm.¹¹⁻² It has been seen that puncture by the arm may be a viable option in patients with some access to jugular and subclavian veins, including rates of infection nil or comparable to central catheters inserted through the thorax. However, it is necessary to consider the inherent limitations of observational studies before instituting this evidence into clinical practice.

It should be emphasized that the puncture of any type of central venous catheter, including ITC, is not recommended by the femoral vein, since there is an increased risk of thrombosis by this site, as well as an increased risk of infections, being considered only in emergency situations.²² In this study, articles that evaluated this place of insertion regarding the risk of infections were not included.

Regarding the length of stay of the ITC, an average time of use of approximately one year was observed in the articles analyzed. It is known that CVC residence time is a factor that influences the occurrence of infection, such as bloodstream, which may occur between 48-72 hours after catheter insertion.²¹

Infection of the bloodstream^{12,16,20}, catheter-related infection^{9,11,16} and infection of the subcutaneous pouch^{10-2,16-7,20} were the most prevalent infections in the studies, with a predominance of gram-negative bacteria, such as *Staphylococcus aureus*^{12,14,16,19,20} and *Staphylococcus epidermis*.^{16,20} In most cases, the catheter had to be removed and the causative agent had to be removed. The clinical conduct of catheter withdrawal corroborates with that recommended by international guidelines, including the 2015 guideline of the European Society for Medical Oncology.²³

It is worth mentioning that bloodstream infection, associated with central venous access, affects approximately 70,000 users per year, representing an estimated annual cost of between US \$ 7,000 and US \$ 29,000. The studies analyzed did not portray the costs related to the treatment of infections, however, infections are known to have a direct impact on patient outcomes, increase length of hospital stay and health care costs.²¹

Two studies evaluated treatment with chemotherapy as a risk factor for the development of infection.^{11,13} In one, the types of treatment by adjuvant and neoadjuvant chemotherapies were compared and it was noticed that treatment by neoadjuvant chemotherapy is associated with a higher risk of infection.¹³ Regarding the other study, chemotherapy was compared to intravenous infusion of fluids in order to identify which solution presented the greatest risk for the development of infections. However, it was noticed that there was no significant difference between the infection rates of the analyzed solutions. For both

studies, the infection was caused by bacteria and fungi.¹¹

In another study, chemotherapy was also one of the causes of infection that influenced the removal of the catheter. Although the mechanism between the incidence of infection and chemotherapy is not fully understood, this observation can be attributed to an early tumor stage, impaired immunity and the number of hospitalizations in some patients. In the same study, the underlying diagnosis ($p < 0.001$), chemotherapy regimen ($p < 0.001$), and antibiotic sensitivity ($p = 0.01$) were reported to be significant factors affecting duration of ICU use.¹⁴ These data were also observed in a study with a significant population ($n = 1391$), where the type of neoplasia, type of chemotherapy and infection were variables that influenced the lower longevity of the catheter ($p < 0.001$).¹³

A randomized clinical trial comparing saline solution versus heparin solution and the relationship with the onset of catheter-related infection was found on the hepatocellularisation process of ICS and its relation to the onset of infections.²⁰ An infection rate was evidenced of 0.03 per 1000 days of catheter in the saline group and 0.10 per 1000 days of catheter in the heparin solution group. The American Society of Clinical Oncology²² recognizes that there is insufficient data to encourage a recommendation, especially regarding blockade of STI and its relation to the incidence of infections.

CONCLUSION

It was concluded that ICU is a type of catheter of prolonged and safe use, since the infection rates are relatively low when compared to the central venous catheters of short stay. Among the incidences of infections associated with the use of ITC, it is observed that bloodstream infection, subcutaneous pocket infection and catheter-related infection were the most prevalent. In this context, the importance of involving all stakeholders in the evaluation and implementation of new technologies and practices that help in minimizing or solving this problem is highlighted.

Although the ITC has several benefits, it is worth noting the absence of national studies on the subject, as elucidated in this review. Of the included studies, only one presented a high level of evidence, demonstrating the need to carry out studies with designs that could subsidize the provision of strong evidence for strategies to reduce infection rates associated with catheter use, in addition

to expanding the knowledge of one comply with current recommendations and regulations.

In addition, the established recommendations regarding this type of catheter are scarce. The studies included in this review point to the lack of relevant data that base the clinical practice, presenting an information gap and evidencing the need to explore the issue for the production of scientific evidence.

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