

Bloodstream infection and bacteremia related to vascular access in patients undergoing hemodialysis

Infección del torrente sanguíneo y bacteriemia relacionadas con el acceso vascular en pacientes sometidos a hemodiálisis

Infecção da corrente sanguínea e bacteremia relacionada ao acesso vascular de pacientes submetidos à hemodiálise

Isabella Luiza Medeiros Dorta^{1*}

ORCID: 0009-0004-0952-5951

Ana Cecília Roversi¹

ORCID: 0009-0003-0208-3479

Maria Stella Tonetti Nassorri¹

ORCID: 0009-0003-3463-5346

Marina Fernandes Pedro¹

ORCID: 0009-0006-3514-1331

Morian Lauana Miguelão

Canada¹

ORCID: 0000-0002-7016-8998

Francine da Silva e Lima de

Fernando¹

ORCID: 0000-0003-4650-3677

Kleber Aparecido de Oliveira¹

ORCID: 0000-0002-7747-4680

¹Centro Universitário de Rio Preto. São Paulo, Brazil.

How to cite this article:

Dorta ILM, Roversi AC, Nassorri MST, Pedro MF, Canada MLM, Fernando FSL, Oliveira KA. Bloodstream infection and bacteremia related to vascular access in patients undergoing hemodialysis. Glob Acad Nurs. 2024;5(2):e428. <https://dx.doi.org/10.5935/2675-5602.20200428>

*Corresponding author:

ilmdenf@gmail.com

Submission: 03-24-2024

Approval: 05-03-2024

Abstract

This study aimed to investigate the occurrence of bloodstream infection and bacteremia related to vascular access in patients treated by the hemodialysis sector of a teaching hospital in the interior of São Paulo. The study was approved by the Research Ethics Committee of the Centro Universitário de Rio Preto under opinion No. 6.125.061 and CAAE No. 69982323.9.0000.5604. Of the 70 notifications, 75% were of bacteremia and 25% of bloodstream infection. The events may be severe or moderate, and of those reported, 84.29% were moderate, and only 15.71% were severe. Indwelling catheters were associated with infections in 81.43%, while arteriovenous fistulas and temporary accesses were associated with infections in 15.71% and 2.86%, respectively. Given this scenario, it is essential to maintain continuous vigilance to prevent serious occurrences, as well as to propose preventive and educational measures in institutions that guarantee the quality and safety of patient care.

Descriptors: Catheter-Related Infections; Bloodstream Infection; Chronic Renal Failure; Hemodialysis; Nursing Care.

Resumen

Este estudio tuvo como objetivo investigar la ocurrencia de infección del torrente sanguíneo y bacteriemia relacionada al acceso vascular en pacientes atendidos en el sector de hemodiálisis de un hospital universitario del interior de São Paulo. El estudio fue aprobado por el Comité de Ética en Investigación del Centro Universitario de Rio Preto bajo dictamen n.º 6.125.061 y CAAE n.º 69982323.9.0000.5604. De las 70 notificaciones, el 75% fueron de bacteriemia y el 25% de infección del torrente sanguíneo. Los eventos pueden ser graves o moderados, y de los reportados, el 84,29% fueron moderados y solo el 15,71% fueron graves. Los catéteres permanentes se asociaron a infecciones en el 81,43%, mientras que las fístulas arteriovenosas y los accesos temporales se asociaron a infecciones en el 15,71% y el 2,86%, respectivamente. Ante este panorama, es fundamental mantener una vigilancia continua para prevenir sucesos graves, así como proponer medidas preventivas y educativas en las instituciones que garanticen la calidad y seguridad de la atención al paciente.

Descriptores: Infecciones Relacionadas con Catéter; Infección del Torrente Sanguíneo; Falla Renal Crónica; Hemodiálisis; Cuidado de Enfermería.

Resumo

Este estudo buscou conhecer a ocorrência de infecção de corrente sanguínea e bacteremia relacionadas ao acesso vascular, em pacientes atendidos pelo setor de hemodiálise de um hospital escola do interior paulista. O estudo foi aprovado pelo Comitê de Ética em Pesquisa do Centro Universitário de Rio Preto sob o parecer de n.º 6.125.061 e CAAE n.º 69982323.9.0000.5604. Das 70 notificações, 75% foram de bacteriemia e 25% de infecção de corrente sanguínea. Os eventos podem ser apresentados de forma grave ou moderada, sendo que dos notificados, 84,29% foram moderados, e apenas 15,71% se apresentaram como graves. Os cateteres permanentes estiveram associados às infecções em 81,43%, enquanto as fístulas arteriovenosas e acessos temporários em 15,71% e 2,86%, respectivamente. Diante desse cenário, torna-se imprescindível manter a vigilância contínua para prevenir ocorrências graves, bem como propor medidas preventivas e educacionais nas instituições, que garantam a qualidade e segurança da assistência ao paciente.

Descritores: Infecções Relacionadas a Cateter; Infecção de Corrente Sanguínea; Insuficiência Renal Crônica; Hemodiálise; Cuidados de Enfermagem.



Introduction

Chronic Kidney Disease (CKD) is a disease that causes a gradual and silent loss of kidney function. When severe stage 5 is reached, the individual develops Chronic Kidney Failure (CKF), which indicates a kidney glomerular filtration rate (GFR) below 15 ml/min; normally, in a healthy kidney, the GFR is 115 ml/min for a body surface area, specifically, for 1.73 m². These patients most often require renal replacement therapies (RRT), such as peritoneal dialysis, hemodialysis (HD), or kidney transplantation¹.

Risk factors such as individuals aged 65 or over, who are or have been smokers, have a sedentary lifestyle, or have high blood pressure, diabetes, or hypercholesterolemia, have a greater chance of being diagnosed with CKD².

When faced with the need to use some TRS, patients face a process that involves approval or rejection, which results in possible effects on the approach to the disease and treatment, since there is a significant impact on the patient's emotional and psychological well-being³.

The nurse's role in promoting patient's health is crucial, involving continuous assessment of health conditions and personalized therapeutic approaches. This assessment plays an essential role in planning nursing actions through educational strategies and daily interventions. The nurse's ability to perceive the patient's needs, taking their unique characteristics into account, is fundamental to providing quality care. The nurse seeks to address all aspects of the patient's needs (physical, emotional, social, and spiritual), aiming to improve quality of life, with an emphasis on identifying the individual and understanding their context as vital components of this care process⁴.

CKD has seen significant growth in prevalence and incidence in countries with diverse economic characteristics, becoming a problematic public health issue. In the latest Brazilian Dialysis Census, in 2021, the estimated prevalence rate was 696 dialysis patients per million population (pmp), with an estimated total of 148,363 patients undergoing treatment that same year. The vast majority were on hemodialysis, with an average of 39,856 (90%) patients. When comparing the kidney transplant waiting list from 2020 to 2021, the number of patients is estimated to have decreased by 2%, from 33,239 (23%) to 30,439 (21%), respectively⁵.

Studies show that the age range of these patients has a higher occurrence between the ages of 45 and 64 years, the predominance between the sexes remained constant, with 59% (25,352/43,176) of men and 41% of women (17,824/43,176), as well as the etiology with hypertension and diabetes that maintain a predominance of the percentage of underlying diseases⁵.

In HD, the patient's blood is filtered through a dialysis device or artificial "kidney," which passes through the dialyzer, which is made up of two compartments separated by a semipermeable membrane: on one side flows the blood and on the other the dialysis solution along with purified treated water, called dialysate; after the blood passes through the entire purification process, it is returned to the patient⁶.

Several types of access can be used in HD treatment, including short-term and long-term central catheters, which are implanted through a large vein in the jugular, subclavian, or femoral vein. Alternatively, arteriovenous fistulas (AVFs) are recommended for patients requiring prolonged or permanent access. Implanted through both a venous and an arterial route⁷.

The use of catheters has a greater potential to contribute to the development of Primary Bloodstream Infections (BSIs), which can lead to future sepsis. Failure to maintain sterile technique during catheter placement can increase the risk of infection⁸.

Studies describe that bloodstream infection (BSI) rates in hemodialysis patients range from 0.5 to 27.1 per 100 patient-months, depending on the type of venous access used. Another important fact is that the implementation of control strategies and measures contributes to reducing the incidence of BSI in these patients, with a range of 1.09–0.89 and 2.04–0.75 per 100 patient-months⁹.

IPCS is a national indicator that must be reported following new institutional standards, which now only require notification in the form of laboratory-confirmed IPC (IPCSL), established according to the following criteria: patients >28 days, with a pathogen identified in one or more blood cultures, with the identified microorganism not related to another infectious focus; and presenting at least one of the signs and symptoms: body temperature >38°C or <36°C, hypotension, chills, apnea or bradycardia¹⁰.

CLABSI is a surveillance diagnostic that establishes rates for comparison between institutions. It is more comprehensive, less specific, and difficult to differentiate between infection types. It can be performed without the need for device removal or more sophisticated blood culture techniques. However, from a clinical perspective, specialized microbiological testing is required to confirm the diagnosis of Vascular Catheter-Related Infection (CBI) and guide therapeutic approaches, such as treatment regimens, device removal, and additional tests¹⁰.

Bacteremia is a common and serious infectious condition in which bacteria enter the bloodstream and spread throughout the body, potentially leading to increased hospitalization, morbidity, and mortality, and financial burdens¹¹. According to the National Health Surveillance Agency (ANVISA), vascular access-related bacteremia occurs when a patient with CKD on hemodialysis presents a positive blood culture, accompanied by at least one of the following symptoms: fever above 38°C, chills, tremors, oliguria or hypotension, provided there are no signs or symptoms of infection in other locations, such as pneumonia or urinary tract infection¹².

Basic precautionary measures are the primary strategy for preventing the spread of Healthcare-Associated Infections (HAIs) between patients and healthcare professionals. These precautions should be applied during patient care, including hand hygiene before and after contact, the use of personal protective equipment such as gloves, masks, goggles, and aprons when there is a risk of contact with biological material, the safe handling of sharp objects, adequate environmental cleaning, the correct



processing of materials and equipment, and the immunization of healthcare professionals¹³.

Hemodialysis is an effective technique for replacing kidney function in patients whose kidneys are insufficient to filter excess toxic substances, salts, and fluids from the blood. However, the therapy can expose patients to several risks during treatment, including infections that may arise during the management of the catheter used for therapy. BSI is one of the main risk factors affecting these individuals and can be a cause of sepsis and even death, subject to variations related to the epidemiological profile of patients and the types of catheters used. Therefore, it is important to monitor infection rates and use this information as a prerequisite for implementing preventive measures. While the importance of deepening knowledge on this topic is clear, studies of this nature contribute to the production of scientific knowledge and healthcare practice.

Thus, the interest in developing this study is justified to analyze and characterize the occurrence of BSI and bacteremia, as well as identify the profile of patients undergoing hemodialysis treatment in a teaching hospital.

Methodology

This is a retrospective, descriptive, and exploratory study with a quantitative approach. Opinions and information are translated into numbers for classification and analysis using statistical techniques. These data are collected from the database of the Hospital Infection Control Service (SCIH) at Hospital de Base (HB) in the city of São José do Rio Preto, São Paulo. HB is one of the largest and most important hospital complexes in the state of São Paulo.

The sample collected was non-probabilistic, investigating patients treated at the nephrology outpatient service who met the following inclusion criteria: chronic kidney disease (CKD), hemodialysis, and bacteremia or vascular access-related bloodstream infection. Exclusion criteria included incomplete medical record information and/or negative blood culture results. Data collection took place at the hospital's SCIH from May 2022 to May 2023. The collected data were analyzed, organized, and synthesized using descriptive statistics, presented in absolute numbers and percentages, and represented in graphs and tables.

For the theoretical basis, the search for articles was carried out using the descriptors in Health Sciences (DeCS/MeSH): Catheter-Related Infections; Bloodstream Infection; Chronic Renal Failure; Nursing Care; Hemodialysis. The selected scientific articles address the study theme as the main subject and were indexed in the Virtual Health Library (VHL), the Latin American and Caribbean Literature in Health Sciences (LILACS), the Nursing Database (BDENF), the Scientific Electronic Library Online (SciELO), and the National Library of Medicine (MEDLINE/PubMed).

The study followed the principles of Resolution No. 466/2012 of the National Health Council and began after approval by the UNIRP Research Ethics Committee (CEP), under opinion No. 6,125,061, CAAE No. 69982323.9.0000.5604. A waiver of the Informed Consent Form (ICF) was requested because it was a retrospective database analysis, that is, before the start of the project.

Results and Discussion

According to the inclusion criteria defined by the study, 70 notifications registered in the dialysis sector of the institution were identified, of which 38 (54%) were women and 32 (46%) were men. Totaling 50 patients, this is because the same patient may have presented more than one notification (Figure 1). The age range based on the notifications was predominantly between the ages of 61 and 70 years (37.14%), with females accounting for 21.43% and males for 15.71% (Figure 2).

These findings align with existing literature, which often reports a higher incidence of chronic kidney disease in women and older adults. The concentration of events among individuals aged 61 to 70 is also consistent with existing literature, which identifies age as a relevant risk factor for the development of kidney complications. However, it is worth noting that demographic distribution may vary regionally and be influenced by socioeconomic factors⁵. The data reveal that most reports classified as bacteremia are moderate, representing 70%, while only 5.71% are considered severe. In contrast, those related to BSI have a severe event rate of 10.00% and a moderate event rate of 14.29%. Overall, most events in the combination of both categories are classified as moderate, representing 84.29%, while severe events comprise 15.71% of the total (Figure 3).

Figure 1. Distribution by sex based on reports collected by SCIH – HB. São José do Rio Preto, SP, Brazil, 2023

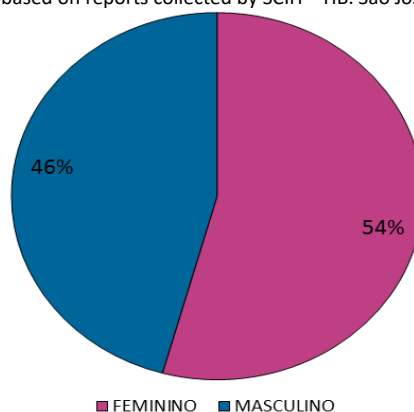


Figure 2. Age range of patients distributed by gender according to notifications collected by SCIH – HB. São José do Rio Preto, SP, Brazil, 2023

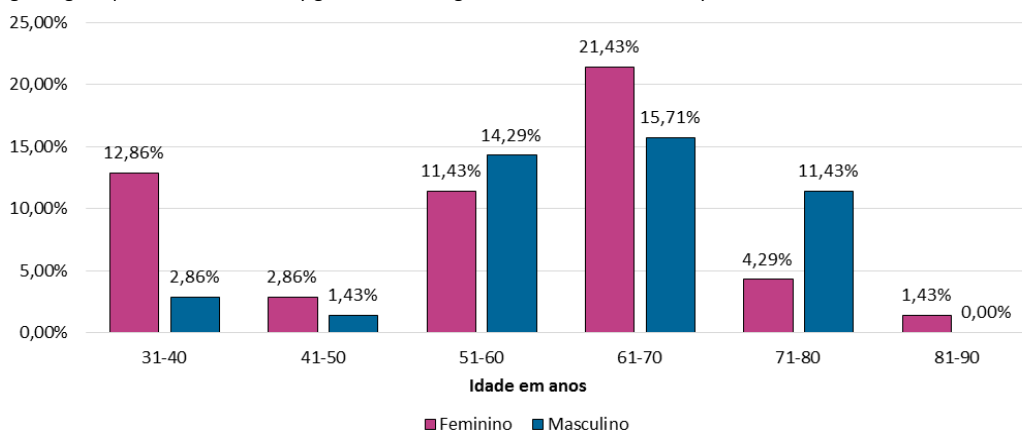
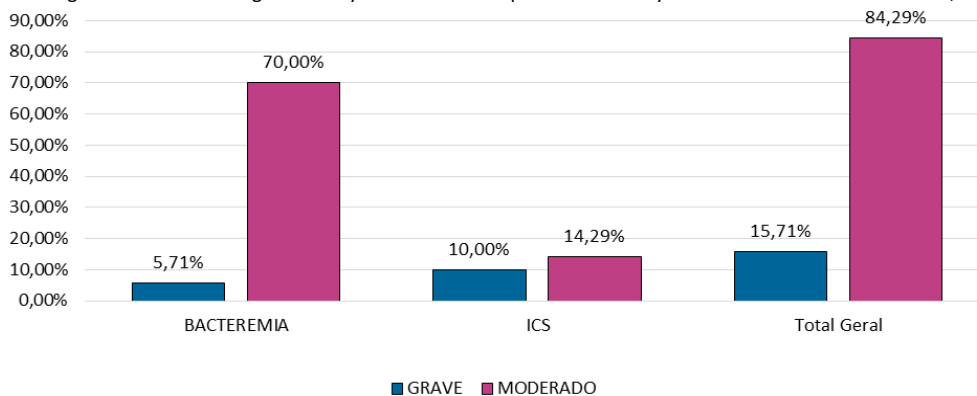


Figure 3. Percentage of events according to severity level based on reports collected by SCIH – HB. São José do Rio Preto, SP, Brazil, 2023



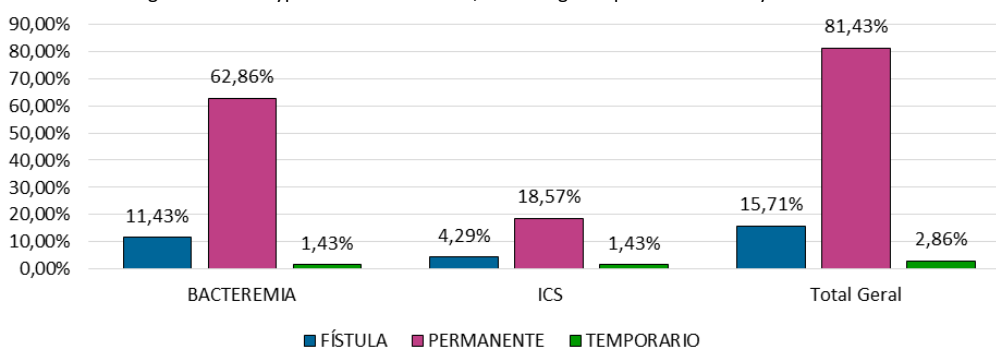
Analyzing the severity of bacteremia and BSI events provides valuable insights into the effectiveness of intervention practices. The predominance of events classified as moderate suggests early detection and effective interventions in these cases. However, the presence of severe events, albeit in a smaller proportion, highlights the continued need for vigilance and improved care practices, corroborating the importance of prevention and appropriate management of infections in hemodialysis patients^{14,15}.

The types of access highlighted in the research are Permanent (Permcath), Temporary (Central Venous Catheter - CVC), or AVF. Regarding the events, the permanent catheter is more predominant than the other accesses with 81.43% of the total, while AVF and temporary accesses contribute 15.71% and 2.86% respectively, to the overall total (Figure 4).

In a study¹⁶ to identify the infection rate of outpatients undergoing HD and implementing a surveillance system recommended by the Centers for Disease Control and Prevention (CDC), the researchers found that the rate of patients who underwent HD via CVC was 42.2% and the risk of bacteremia was 17.6 times higher than in patients with AVF. Most microorganisms responsible for BSIs were Coagulase-negative Staphylococci 10 (27%) and Staphylococci Aureus 7 (18.9%).

Surveillance and the pursuit of quality in healthcare play a fundamental and essential role, contributing to patient safety in HD, as it also involves other particularities such as effectiveness, use of technologies, and ongoing education of healthcare professionals, among others.

Figure 4. Percentage of events according to the main types of vascular access, according to reports collected by SCIH – HB. São José do Rio Preto, SP, Brazil, 2023



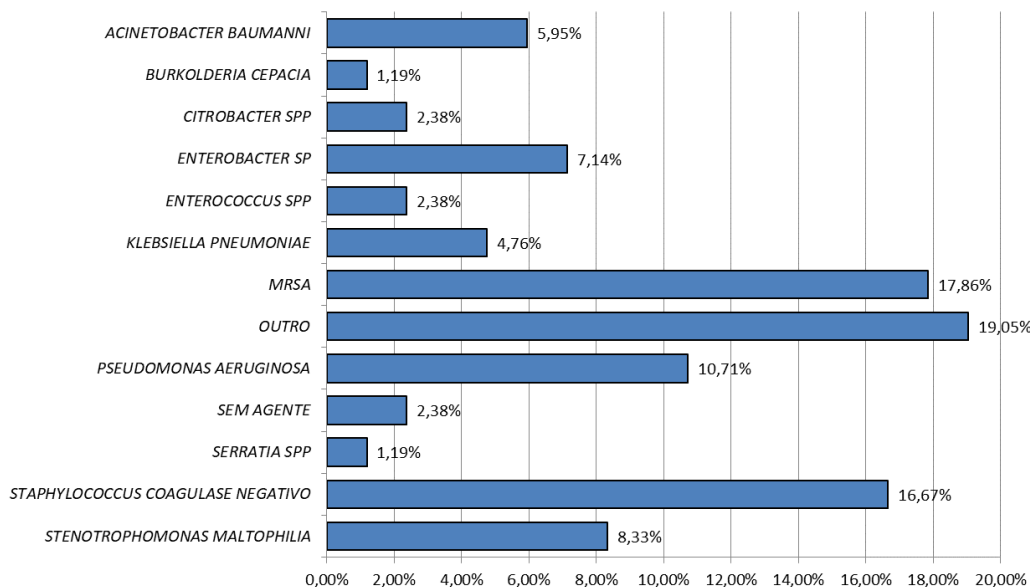
The type of vascular access used during hemodialysis has emerged as a crucial point of discussion. According to the study¹⁷, catheters are an important risk factor for bacteremia in patients undergoing dialysis treatment, the use of a temporary catheter presents a 50% higher risk of septicemia than patients with AVF, in addition, the use of a central venous catheter is associated with an 11.2 times higher risk of BSI compared to the use of an arteriovenous fistula.

The most prevalent complications related to hemodialysis vascular access are reduced blood flow, bleeding, and infection or established infection. These adverse events can worsen and result in more complex interventions, such as hospitalizations, as well as compromise the access's function, requiring replacement. However, these complications can be avoided or minimized if proper venous access care is performed by healthcare professionals and the patient themselves. When properly informed about treatment recommendations, they become jointly responsible for preventing complications or loss of

hemodialysis vascular access, contributing to therapeutic efficiency¹⁸.

Analysis of microorganisms isolated from blood cultures of patients observed in the study revealed a diversity of microorganisms present, with both Gram-positive and Gram-negative bacteria standing out. Among Gram-positive bacteria, we observed the significant presence of MRSA (methicillin-resistant *Staphylococcus aureus*) with 17.86% of reports, coagulase-negative *Staphylococcus* (16.67%), and *Enterococcus* spp (2.38%). On the other hand, in the group of gram-negative bacteria, *Pseudomonas aeruginosa* (10.71%), *Stenotrophomonas maltophilia* (8.33%), *Enterobacter* spp (7.14%), *Acinetobacter baumannii* (5.95%), *Klebsiella pneumoniae* (4.76%), *Citrobacter* spp (2.38%), *Burkholderia cepacia* (1.19%), and *Serratia* spp (1.19%) were identified. The notifications classified as "Other" microorganisms were not made available by the service, and those labeled as "No agent" are those that were not identified by the service (Figure 5).

Figure 5. Microorganisms isolated in blood cultures of outpatient hemodialysis patients with bacteremia and/or BSI according to reports collected by the SCIH – HB. São José do Rio Preto, SP, Brazil, 2023



The results of the study, covering various clinical conditions, revealed a diversity of gram-positive and gram-negative bacteria, highlighting strains of *Staphylococcus* and *Enterococcus* among the gram-positive bacteria. Compared to a study¹⁷ specific on bacteremia in hemodialysis patients, where Gram-positive bacteria, especially *S. aureus* and MRSA, and Gram-negative bacteria such as *E. coli*, *Enterobacter* spp., and *Klebsiella* spp., predominate, vary in infection patterns. This divergence highlights the influence of specific clinical conditions, emphasizing the importance of prevention strategies tailored to different infection patterns, especially in high-risk populations such as hemodialysis patients.

In a study⁹ aimed to identify risk factors for the development of BSI in 162 hemodialysis patients (81 cases and 81 controls) reported that Gram-positive bacteria were isolated more frequently (72%), and patients with CVCs had

a higher chance (11.2%) of developing BSI compared to those using AVFs. The researchers emphasize that BSI prevention measures related to CVC use should be intensified. The diversity of infectious agents highlights the importance of a comprehensive approach to diagnosis and treatment, considering antimicrobial resistance and specific characteristics of each organism to ensure effective therapeutic strategies.

Research highlights the vital importance of keeping catheters free of infection, thus underscoring the continued effectiveness of nursing interventions to ensure the safety and well-being of patients undergoing catheter-based hemodialysis. It is widely recognized that catheter-associated infections not only result in high costs but also prolong hospital stays, increase morbidity, and contribute to mortality in healthcare settings^{19,20}.



The implementation of preventive measures, such as aseptic practices, antisepsis, appropriate staff attire, meticulous catheter maintenance, close monitoring for signs of infection, ongoing staff education, and patient self-care guidance, plays a fundamental role in reducing these infections. In this context, nursing plays a crucial role in developing protocols for access management in hemodialysis patients, promoting safer and more effective practices^{19,20}.

According to the CDC, adherence to BSI prevention strategies in dialysis requires effective action by doctors, nurses, care staff, and even patient engagement and involvement in the care itself²¹.

Final Considerations

The limitations of this study are primarily related to the limited availability of patient information and the incompleteness of the data provided by the unit. Limited access to patient information can hinder obtaining a comprehensive and detailed overview of the cases analyzed, potentially affecting the accuracy and generalizability of the results. These limitations highlight the importance of careful interpretation of the results and consideration of potential

limitations for a proper understanding of the findings obtained from the Hospital Infection Control Service database, especially in the context of outpatient nephrology care and the established inclusion criteria. Based on the results presented, we can conclude that the study analyzed a significant set of reports related to adverse events in patients undergoing hemodialysis at one institution. Most reports involved female patients aged 61 to 70 years.

Regarding the severity of the events, most were classified as moderate, with a significantly smaller percentage considered severe. Furthermore, the types of access used for dialysis were identified, with permanent catheters being the most prevalent, followed by AVF and temporary accesses. This may provide useful information for risk management and improving care practices for dialysis patients, particularly regarding the use of different types of accesses.

In this context, the results highlight the importance of surveillance and continuous evaluation of patient safety in dialysis units, with a special focus on patient demographic characteristics, the severity of adverse events, and the type of access used to improve the quality of care and reduce the risk of serious adverse events.

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