

RESEARCH

Central venous catheter-associated infections in adults undergoing hemodialysis

Infecciones asociadas a catéter venoso central en adultos en proceso de hemodiálisis

Infecções associadas a cateteres venosos centrais em adultos submetidos a hemodiálise

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Abstract

Introduction: The central venous catheter used for haemodialysis is the alternative for patients suffering from chronic renal failure, where nursing professionals participate. **Objective:** To identify the prevalence of infections related to the central venous catheter in hemodialysis patients from a clinic in Mexico. **Methodology:** Retrospective and descriptive quantitative study. The source of information were files of the total population of patients attended in 2018 that corresponded to 29 users and epidemiological actions performed in the study period and results

reported in the logbook of the head nurse of the hemodialysis area. **Results:** Staphylococcus epidermidis was found in an amount of 43%. Fourteen percent (14%) of the cases of catheter-related bacteremia were related to nosocomial bacteremia; hand cultures were performed on all the nursing personnel in the different shifts, reporting the presence of staphylococcus epidermidis in 60% of the personnel and coagulase-negative staphylococcus in 60% of the furniture in the hemodialysis area. **Conclusion:** The need to reinforce infection prevention measures related to central venous catheter handling procedures, including the unification of asepsis protocols and management of permanent vascular accesses by healthcare personnel, became evident.

Key words: Continuous renal replacement therapy; Catheter related infections; In hospital hemodialysis units; Nursing (DeCS).

Resumen

Introducción: El catéter venoso central utilizado para hemodiálisis es la alternativa para los pacientes que se encuentran padeciendo insuficiencia renal crónica, en donde intervienen los profesionales de enfermería. **Objetivo:** Identificar la prevalencia de infecciones relacionada al catéter venoso central en pacientes con hemodiálisis de una clínica en México. **Metodología:** Estudio cuantitativo retrospectivo y descriptivo. La fuente de información fueron expedientes de la población total de pacientes atendidos en el año 2018 que correspondió a 29 usuarios y acciones epidemiológicas realizadas en el periodo de estudio y resultados reportadas en la bitácora de jefe de enfermería del área de hemodiálisis. **Resultados:** Se encontró con un 43% staphylococcus epidermidis, el 14% de los casos de bacteriemia relacionada a catéter fue relacionada a bacteriemias nosocomiales; Se realizó cultivo de manos de todo el personal de enfermería en los diferentes turnos reportando la presencia de staphylococcus epidermidis en 60% del personal y staphylococcus coagulasa negativa en 60% del mobiliario del área de hemodiálisis. **Conclusión:** Se evidenció la necesidad de reforzar las medidas la prevención de infecciones relacionadas al catéter venoso central en los procedimientos de manipulación, incluyendo la unificación de los protocolos de asepsia y manejo de accesos vasculares permanentes por el personal de la salud.

Palabras clave: Terapia de reemplazo renal continuo; Infecciones relacionadas con catéteres; Unidades de hemodiálisis en hospital; Enfermería (DeCS).

Abstrato

Introdução: O cateter venoso central utilizado para hemodiálise é a alternativa para doentes que sofrem de insuficiência renal crônica, onde intervêm profissionais de enfermagem. **Objetivo:** Identificar a prevalência de infecções relacionadas com CVC em doentes em hemodiálise numa clínica no México. **Metodologia:** Estudo quantitativo retrospectivo e descritivo. A fonte de informação foram arquivos da população total de pacientes atendidos em 2018 que corresponderam a 29 usuários e ações epidemiológicas realizadas no período do estudo e resultados relatados no diário de bordo da enfermeira chefe da área de hemodiálise. **Resultados:** Staphylococcus epidermidis foi encontrado em 43%, 14% dos casos de bacteriemia relacionada a cateteres estavam relacionados a bacteriemia nosocomial; foram realizadas culturas de mãos em toda a equipe de enfermagem nos diferentes turnos, relatando a presença de Staphylococcus epidermidis em 60% da equipe e Staphylococcus coagulase-negativo em 60% dos móveis da área de hemodiálise. **Conclusão:** Ficou evidente a necessidade de reforçar as medidas de prevenção de



infecções relacionadas aos procedimentos de manuseio de cateteres venosos centrais, incluindo a unificação dos protocolos de assepsia e o gerenciamento de acessos vasculares permanentes pela equipe de saúde.

Palavras-chave: Terapia de substituição renal contínua; Infecções relacionadas ao cateter; Unidades de hemodiálise hospitalar; Enfermagem (DeCS).

Introduction

Renal failure or renal disease can be treated by means of renal replacement therapy in hemodialysis (HD), as well as related therapies such as hemofiltration and hemodiafiltration, which, together with medical and nutritional measures, improve the prognosis by influencing the evolution of patients with renal failure ⁽¹⁾.

Around 81-90% of patients with end-stage renal disease (ESRD) start HD ⁽²⁾. In order to have access to the bloodstream, a vascular access (VA) is required, and although scientific evidence agrees that the autologous arteriovenous fistula (AVF) is the first and best VA option, it is not always possible to perform it, and although these catheters have a long useful life, their use usually causes complications of mechanical or infectious origin ⁽³⁾. A safe and continuous approach to the intravascular space allows a blood flow between 300 ml to 500 ml per minute, a long half-life and a low percentage of mechanical and infectious complications ⁽⁴⁾.

Although the construction of the tunneled central venous catheter (CVC) is made of silicone, polyurethane or their copolymers and has a Dacron handle for subcutaneous anchorage, the appearance of bacteria and their proliferation have been reported previously ^(5, 6). The following are other factors that favor the occurrence of bacteremias: Rotation of nursing personnel between patients and machines, as well as patient incidents and machine alarms, the nurse/patient relationship, the assignment to different shift sessions, the lack of continuous patient education and patient safety programs, as well as inadequate infrastructure.



It is also important to establish the proper way of preparing, handling and administering medications during the HD or at the end of the procedure. It is important that the personnel involved in the area be trained, for example, the cleaning personnel is responsible for the cleaning and disinfection process of the areas, the nursing personnel is responsible for the sanitization of material and equipment, so the personnel can be a factor in decreasing or increasing the sources of infections.

The criteria that a catheter-related bacteremia (CRB) must meet are the following: at least two positive blood cultures, one by peripheral vein puncture and another through the CVC, for quantitative or qualitative blood cultures with continuous monitoring of the growth time, and that in both the same microorganism appears in a ratio greater than or equal to 5:1 in the samples taken through the catheter with respect to those obtained by peripheral puncture ^(3,7). The use of solutions with antibiotics and heparin, as well as sodium citrate ⁽⁵⁾, is mentioned as reference to prevent infections within the various regulatory frameworks.

The processes of cleaning and disinfection of both equipment and environmental surfaces have changed to reduce the risk of reservoirs and sources of infections, so constant training on this point has become more important ⁽⁷⁾. Adherence to hand washing as proposed by the World Health Organization is fundamental to reduce and prevent infectious processes ⁽⁸⁾. Patients on chronic HD have a high risk of presenting nosocomial infections; it is estimated that between 15 and 30% of nosocomial bacteremias are related to the use of percutaneous intravenous devices ⁽⁹⁾. Some studies indicate that *Staphylococcus aureus* is responsible for 40 to 80% of the cases of bacteremia in HD patients ⁽¹⁰⁾.

Among the routes of contamination described so far, two types can be distinguished: Exoluminal contamination, due to the insertion of the CVC, which implies the loss of skin integrity, and inadequate asepsis of the insertion point during the use of the catheter, which can facilitate infection



of the subcutaneous tissue that surrounds the catheter, causing colonization of its exoluminal side⁽⁹⁾. It is important to mention that, within CRB, low-risk episodes allow CVC to be maintained since 80% of the cases associated with coagulase-negative staphylococcus respond to antibiotics⁽¹¹⁾. In cases of moderate risk, temporary catheters should be removed, a catheter infected by candida spp, even with a correct treatment, is a mortality factor according to some authors, the mortality rate reaches 35% to 65% independently if candidemia persists^(12, 13). In the high-risk group, removal of the CVC is required in all cases due to coagulase-negative staphylococcus and a 7-day treatment with a glycopeptide is considered adequate. In cases due to staphylococcus aureus, intravenous treatment for 10 to 14 days is recommended. In CVC infections due to candida spp. systemic treatment with intravenous sealing with antibiotic should be administered in all cases. In this respect, the nursing personnel has a great participation because they are the ones who perform and participate in HD procedures to contribute to provide efficient health services, with quality and safety for the patient⁽¹⁴⁾.

Taking into account all of the above, the objective of this research was to identify the prevalence of CVC-related infections in HD in a clinic in Mexico.

Methodology

Quantitative, descriptive and retrospective study. The total study population corresponded to 29 files of patients undergoing renal replacement therapy in the HD area during 2018. The following were excluded: Patient records that were attended outside the indicated period, outside the HD unit. The variables considered were: CVC carrier, presence of infection, presence of CRB and nosocomial bacteremia, types of causative microorganism, age, sex, disease status, types of HD sessions, number of HD sessions, management shift and type of catheter. Epidemiological actions carried out during the study period and report of results in the logbook of the head nurse of the HD area.



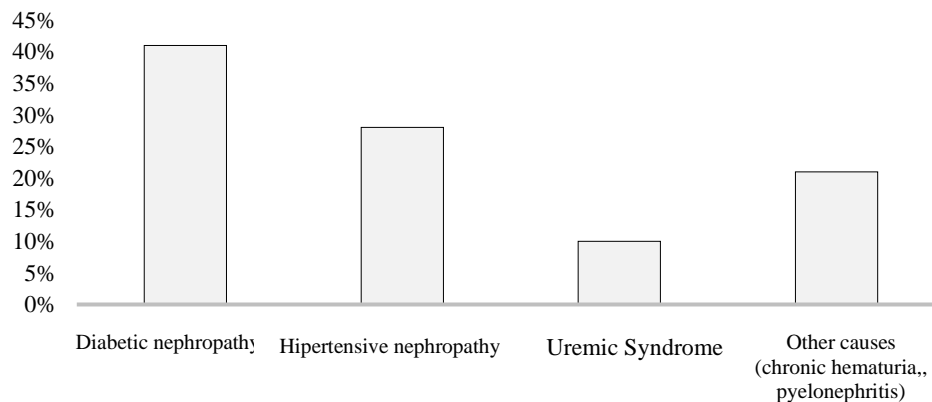
Data collection was performed through the review of clinical records and based on NOM-004-SSA3-2012; the information included in the clinical record was handled with discretion and confidentiality for all personnel of the facility. Approval was obtained from the clinic with official letter Dir06019. Based on the Regulations of the General Health Law on health research, this was considered a risk-free research.

The Statistical Package for the Social Sciences (SPSS) version 26 was used for data analysis. The data were processed using descriptive statistics (frequencies and percentages).

Results

Sixty-two percent of the patients were between 50 and 65 years of age; 24% were between 66 and 75 years of age; and 14% were between 76 and 89 years of age. When stratified by sex, 52% were women and 48% were men. According to the diagnosis for which they were admitted to the HD area and the CVC was installed to receive renal replacement therapy, 41% had diabetic nephropathy, 28% had hypertensive nephropathy, 10% had uremic syndrome, and 21% had other causes such as chronic hematuria, pyelonephritis, etc. (Figure 1).

Figure 1. Diagnosis of admission to the hemodialysis unit, 2018 (n=29)



Source: Own development.

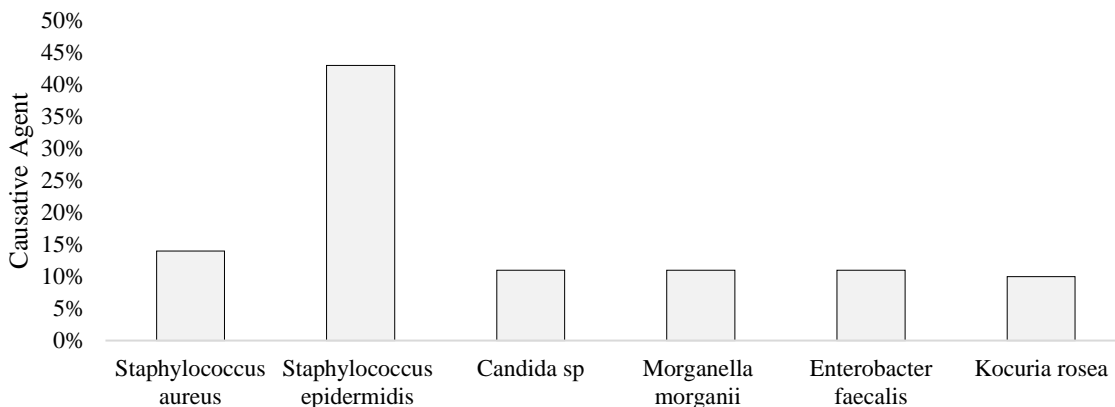


Among the types of CVC, 69% were tunneled and 31% were non-tunneled. The insertion site was the internal jugular vein with 72%, the left external jugular vein with 14%, and the subclavian vein with 14%. The type of CVCs reported for use in patients in the records were: Temporary 31% (Mahurkar), permanent 69% (Permacath 45%, Palindrome 10%, Cannon 10% and Arrow 4%).

According to the duration time of each HD session, this was three hours with 79%, followed by three and a half hours with 14% and 7% was two and a half hours; when looking for the frequency of the procedures it was found that patients received three sessions per week with 72% and only 28% of patients had two sessions per week.

Within the population analyzed, 82% of the cases corresponded to CRB, of which the causative agents were staphylococcus epidermidis in 43%, staphylococcus aureus with 14%, candida spp, morganella morganii and enterobacter faecalis with 11% respectively, and kocuria rosea with 10% (Figure 2).

Figure 2. Recurrent pathogen in the hemodialysis unit, 2018. (n=29).

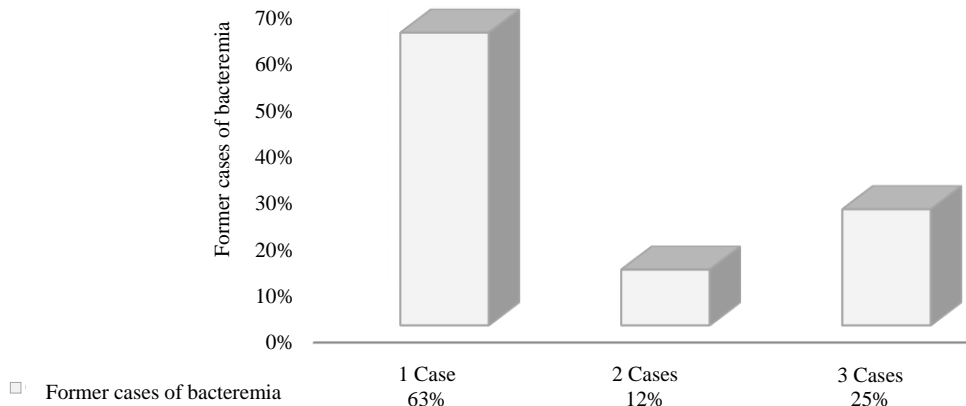


Source: Own development.



Figure 3 shows that 63% of patients showed one episode of bacteremia, 25% had three cases of bacteremia and 12% had two cases of bacteremia. By presenting one case, they are more likely to acquire another bacteremia in the future if proper management fails.

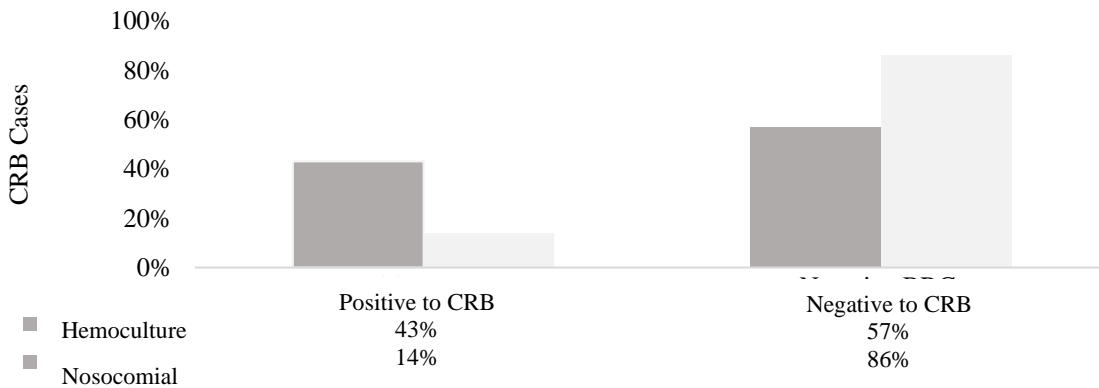
Figure 3. Previous cases of catheter-related bacteremia, 2018 (n=29)



Source: Own development.

After detecting the cases of bacteremias, blood cultures were performed and, systemically, it was found that within organisms 43% were positive for bacteria, which according to the criteria is called CRB, of which only 14% were related to nosocomial bacteremias and 86% were not classified as nosocomial (Figure 4).

Figure 4. Catheter-related/nosocomial bacteremia ratio, 2018 (n=29)

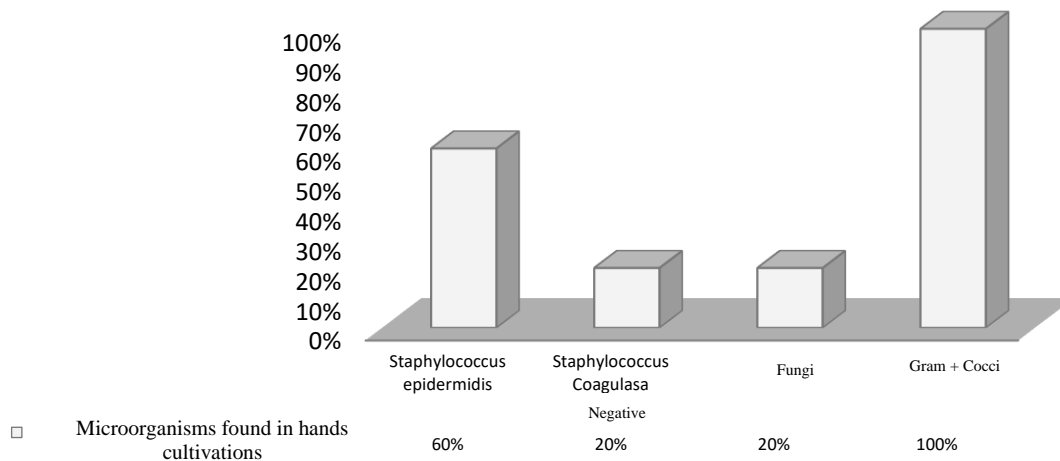


Source: Own development.



In trying to understand the possible origins of the cases of bacteremia showed by the patients, reports or notes from the different people in charge were searched and it was found that that year, after the nursing manager requested hand cultures from all the nursing personnel assigned to HD, it was found that 100% were carriers of gram-positive cocci, 60% were positive for staphylococcus epidermidis and 20% were positive for coagulase negative staphylococcus, as well as fungal growth (Figure 5).

Figure 5. Manual culture of hemodialysis personnel, 2018 (n=5)



Source: Own development.

In addition to this, a bacteriological analysis of equipment, furniture and surfaces of the HD service was performed and the following agents were found: 60% coagulase negative staphylococcus, occurrence of fungi with 36%, (Table 1).

When analyzing the data related to the causal agents of the bacteremias found and the bacteria that appeared in the manual cultures of the personnel appointed to HD, a 60% ratio was seen for staphylococcus epidermidis and the same percentage for the rest of the equipment in the area, but with the causal agent named staphylococcus coagulase negative.



Table 1. Bacteriological sampling of the hemodialysis area, 2018 (n=1)

Surface area/furniture or equipment	Coagulase-negative Staphylococcus	Fungal Development	No Development
Level 1,2,3	*		
Equipment 1	*		
Equipment 2			*
Equipment 3			*
Armchair 1	*		
Armchair 2			*
Armchair 3	*		
Doors			*
Red car	*	*	
Drawer		*	
Garbage can		*	
Monitor c/DEA (ADE)	*		
Computer	*		
Keyboard	*	*	
Desk	*	*	
Walls		*	
Sink			*
TV	*		
A/C			*
Telephone	*		
Floor	*		
Windows		*	
Showcase	*	*	
Shelf	*	*	
Scale	*		
Pasteur table			*

Source: Own development.

Discussion

In relation to the objective of identifying the prevalence of infections related to CVC in HD in a clinic in Mexico, similarities were found with respect to age, between this study and that of other authors (15, 16), involving people between 54 and 64 years of age, thus reaffirming that age could be a factor associated with catheter infections. The variable of sex in the prevalence of infections related to CVC in HD was mostly women, the positions evidenced by the scientific production is that it can be in both women and men (15,16, 18, 19).



The causes that led to the replacement of kidney function were chronic complications resulting from diabetes and high blood pressure, which are the most frequent, but also diabetic nephropathy, hypertensive nephropathy, uremic syndrome, chronic hematuria, and pyelonephritis. Authors of a study showed similar results where the cause of end-stage RD were diabetic nephropathy, glomerulonephritis, cystic RD, obstructive nephropathies, hypertensive nephropathy, familial RD and other unknown causes ⁽¹⁹⁾. As can be seen, chronic degenerative diseases continue to prevail as a risk factor. According to another study ⁽²⁰⁾, it is important to consider existing comorbidities for the choice of CVC for HD such as severe peripheral arterial disease, coronary artery disease and diabetes. Besides, it has been reported that risk factors associated with infection included old age, severity of disease, specific immune system defects associated with renal dysfunction among others ⁽¹⁷⁾.

Mainly, the types of CVCs reported for use in patients in the records were the permacath and the mahurkar, and tunneled CVCs predominated. Other studies identified temporary catheter in less than half of their sample, and permanently tunneled catheters in one-fifth of the population ⁽²¹⁾. It also matches data reported by other researchers, where the use of non-tunneled CVCs was used less frequently compared to tunneled ones ⁽²²⁾; one study reported that tunneled and non-tunneled CVCs showed no difference in reaching the endpoint of catheter-related infections and catheter malfunction ⁽²³⁾, in contrast another study reported that the studied patients had tunneled (long-duration) CVC and the findings showed that CVC use was the independent risk factor for the occurrence of bloodstream infections among HD patients compared to AVF ⁽¹⁷⁾. It is important to point out that increased local infections, decreased flow in dialysis, and obstructions can appear in non-tunneled CVC.

According to the studies found, it can be said that inadequate handling or excessive manipulation increases the risk of CRB. The need to perform HD with tunneled CVC has been increasing in



recent years for various reasons, despite the fact that there are studies showing that such VA increases patient morbidity and mortality ⁽³⁾.

In this study, the insertion site most frequently used for CVC placement for HD was located in the internal jugular vein in more than half of the population, and less frequently in the left external jugular vein and the subclavian vein, These results differ from those found by researchers where the CVC insertion site was the subclavian vein as the most frequent site, followed by the internal jugular and femoral veins ⁽²⁴⁾; another study reported that CVCs were placed in the right internal jugular vein, in the left internal jugular vein, in the right femoral vein and the remaining in the jugular vein ⁽²⁵⁾. Several authors ^(24, 25) mentioned that the development of CVC-related infection was reported independently of the site; however, one of the variables included in both studies was the time of CVC use, a variable that was not reported in this study.

The presence of bacteremias found were positive for CRB in less than half of the population, slightly more than one tenth were related to nosocomial bacteremias and more than three quarters were not classified as nosocomial; in this regard, according to some authors ⁽²⁶⁾, bloodstream infections related to CVC represented around 15% of the infections related to health care, a frequent cause of nosocomial bacteremia, which represented 25% to 43% of all bacteremia episodes. According to this indicator, the results of this study are within these statistics.

Regarding the type of microorganism causing CRB, in the present study, staphylococcus epidermidis, staphylococcus aureus, enterobacter faecalis, kocuria rosea, candida sp and morganella morganii were reported in order of importance. These results match with the main microorganisms found in other studies, such as those reported in a study that identified methicillin-sensitive staphylococcus aureus, coagulase-negative staphylococcus, enterococcus faecalis, enterobacter spp, klebsiella spp, pseudomonas spp, stenotrophomonas spp, escherichia coli and others ⁽²⁷⁾, while another study reported the microorganisms isolated in blood culture, where the



following predominant microorganisms were ⁽¹⁵⁾ staphylococcus aureus, coagulase-negative staphylococci, staphylococcus epidermidis, enterococcus faecalis, streptococcus agalactiae, klebsiela pneumoniae carbapenemase, acinetobacter baumannii and serratia marcescens. Other authors found morganella morganii to cause vascular access sepsis in hemodialyzed patients ⁽⁹⁾ and in the studies analyzed kocuria rosea was not identified. CRB occurred in most HD units because it is a complication due to carelessness and poor patient education or CVC improper handling by the nursing personnel. This defines whether the catheter-related bacteremia is nosocomial as a result of personnel in the HD area, in the environment despite thorough disinfection of the HD area, or whether the bacteremia agent was acquired by the patient at home or someplace visited by the patient during his or her daily activities ⁽²⁸⁾.

This research is mentioned because the causal agent that appeared in most cases of CRB was staphylococcus epidermidis. This bacteria commonly lives on the skin, but it may be a nosocomial case. Staphylococcus epidermidis is a cause of endogenous infection in HD patients. The colonization is associated with the time elapsed until the first bacteremia as well as the recurrence of infection. It is necessary to quickly identify colonized patients and evaluate decolonization protocols ^(28,29). A research reported that associated infections were confirmed in more than half of CVC-dependent HD patients in whom staphylococcus epidermidis infection was suspected and presented with atypical symptoms. Metastatic infection is relatively uncommon, and death due to intravascular catheter-related infection is rare ⁽³⁰⁾.

Regarding the microorganisms located on furniture and on the hands of the nursing personnel who worked in the HD service in different shifts during 2018, it was found that all of them were carriers of gram-positive cocci, and more than half tested positive for staphylococcus epidermidis and one fifth were positive for coagulase-negative staphylococcus, as well as for fungal growth. Thus, in relation to this, it has been reported that within the action lines for hospital sanitation the choice



and use of hospital disinfectants is common, which is why it is necessary to carry out cleaning procedures for different areas, cleaning blood and body fluid spills, disinfection of instruments and equipment used in the patient and hospital environment, as well as health management of clothing⁽³¹⁾. Therefore, it is important to note that in this study there was no information on the actions for disinfecting the furniture, moments, time and type of solution used, as well as solutions used for washing the hands of health professionals, which are widely variable and known as a source of contamination within the management of the patient in renal replacement therapy because they are widely preventable factors.

Importantly, the optimal duration and access of infusion set for CVC-related bloodstream infection in HD is unclear^(31, 32). Guidelines recommend chronic HD through an AVF. However, permanent CVCs are used in a significant number of patients. The use of a tunneled catheter is acceptable if the estimated time to HD is less than one year or it is not possible to create an AVF^(33, 34). As the different referenced studies always mention, the most common complications of CVC for HD are bloodstream infections related to CVC, hence the importance of determining the variables and prevalence of infections⁽³⁵⁾.

Conclusions

When identifying the prevalence of infections related to CVC in adult patients receiving HD, follow-up should be mandatory where improvements can be pointed out in order to guarantee patient safety. Long-term care of CVCs, as well as epidemiological control, and the use of aseptic measures are essential to avoid complications or death of the patient. Thus, education and monitoring of the proper management of both the CVC carrier and the medical, nursing and chemical personnel who are in contact with these patients and who handle the CVC are permanently considered. Therefore, it is necessary for the care professional to implement a series



of strategies that include the various variables that can occur in CRB. A clear limitation of the study was not considering the time of CVC use and the time that the patient has to be treated with renal replacement therapy, as well as the time and training of the personnel who rotate through the HD service.

Conflicts of interest

The authors stated that they have no conflicts of interest.

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