Cell. Mol. Biol. (ISSN: 1165-158X)

Journal Homepage: www.cellmolbiol.org

Cellular and Molecular Biology

Original Article

Incidence of catheter-association bloodstream infection among hemodialysis patients at Erbil Teaching Hospital

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Article Info

Article history:

Received: February 04, 2024
Accepted: September 13, 2024
Published: October 31, 2024

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Abstract

The study objectives were to analyze catheter-associated bloodstream infection (CABSI) risk factors in chronic kidney disease on regular hemodialysis and identify the bacterial species responsible for this by molecular analysis. This research was conducted in Erbil Teaching Hospital-Dialysis Unit in Erbil City-Kurdistan Region-Iraq from January to June 2024. It has been performed on 100 hemodialysis samples from both males and females. The investigation showed that the prevalence of CABSI among hemodialysis patients was 44 (44%) out of 100 (100%). The highest percentage of patients were aged between 60-69 years (32%, OR= 0.9, 95%CI [0.1-2.4], P< 0.001) and also male (66%, OR=2.7, 95%CI [0.9-9.4], P< 0.032). Additionally, the patients with Diabetes Mellitus were 70%, (OR= 6.3, 95%CI [0.3-10.4], P< 0.031), and with hypertension was 92%, (OR= 3.1, 95%CI [0.21-5.4], P<0.02. However, the dialysis duration of most patients was between 1-3 months (60%, OR=0.1, 95%CI [0.1-3.2], P<0.006) and the majority used two catheters (52%, OR= 0.6, 95%CI [0.1-3.2], P<0.012). The most common pathogens identified were Staphylococcus epidermis (44 cases, 100%), Pseudomonas aeruginosa (29 cases, 66%), and, Acinetobacter baumanni (24 cases, 55%). Thirteen bacterial species were recorded in the NCBI GenBank database. The phylogenetic tree demonstrated the distribution and relationship between these bacteria in hemodialysis patients. It showed that the bacterial species were closely related. To lower the risk of catheter-associated bloodstream infection, medical staff should actively develop countermeasures and gain a thorough understanding of the risk factors, which include age, diabetes, length of catheterization, and catheterization site.

Keywords: Hemodialysis, Catheter-associated bloodstream infection, Bacterial infection, Phylogenetic analysis.

1. Introduction

Globally, chronic renal disease affects around 10% of the population and is a public health concern[1]. This higher percentage is associated with the high rates of obesity, non-communicable diseases, and aging worldwide. Renal replacement therapy, on the other hand, significantly enhanced the management of chronic renal illness, with hemodialysis being the most commonly utilized replacement therapy in both developed and developing nations [2]. Hemodialysis is a synthetic procedure that uses machine 2 to purge the blood of wastes and extra water. Hemodialysis has advanced since it was first used in 1945 to become a life-saving therapy and enhance the quality of life for millions of people with renal illnesses worldwide [2, 3]. Although hemodialysis can save lives, some problems, including infection and cardiac arrest, have been documented [4].

The mechanism of hemodialysis depends mainly on the excretion of toxins through the application of an external filter (dialyzer) that includes a semipermeable membrane. Separation of wastes is accomplished by counter-current flow gradient, as the blood flows in one direction and dialyzer fluid flows in the opposite way [3, 4]. Catheters used for hemodialysis are extracorporeal catheters that are commonly characterized by wide sinus central venous lines allowing blood to in and out of patients' vessels. These catheters help in temporarily transporting the blood from the body to an extracorporeal machine to perform the hemodialysis. The hemodialysis catheters could be placed directly throughout the skin to target the vein or they could be placed under the skin throughout the short subcutaneous tunnel into the way to the vein that is secured by the cuff of local tissue depending on the planned duration of hemodialysis [5].

Temporary vascular access to hemodialysis is achieved by a central venous catheter. The central venous catheters are accompanied by many complications mainly the infection. The catheter-related infections are either catheter-related local infections or catheter-related bloodstream infections. Catheter-related infections mainly catheters bloodstream related infections are associated with a great burden on national health costs, many co-morbidities, and high mortality rates [6, 7]. The main cause of high death rates in patients with end-stage renal diseases on hemodialysis was cardiovascular diseases followed by infection [8]. Many authors identified temporary catheter-related

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Doi: http://dx.doi.org/10.14715/cmb/2024.70.10.23

infection among hemodialysis patients in the incidence of about 0.6 to 6.5 llll9itimes/1000 catheters in one day [9-11]. It was found that main microorganism responsible for temporary catheter-related infection was *Staphylococcus aureus* [12-14]. The urgent inserting of tunneled catheters is the following difficulty facing permanent vascular catheters used for hemodialysis. The catheter-related bloodstream infections of tunneled catheters present in a range of 1.1–6.1 times/1000 catheters in one day [15]. Exploring risk factors for catheter-related infections in all types is essential in planning for the development of prevention strategies decreasing the incidence rates of infection and lowering morbidity and mortality rates. The risk factors for catheter-related infection are variable with different literatures which might be elderly age, the duration of catheter application, diabetes mellitus, anemia, and albumin level [16, 17].

In Iraq, the chronic renal disease incidence is high with increasing demand for hemodialysis or kidney transplants [18]. Patients with end-stage renal diseases in the Kurdistan region are unfortunately characterized by poor quality of life. Hemodialysis complications in Iraq are commonly mild to moderate including anemia, edema, hypertension, and poor daily activities [19, 20]. Hemodialysis catheter-related infections are frequent and need strict policies for prevention [21, 22]. This study aimed to identify the risk factors of catheter-related bloodstream infection in chronic kidney disease on regular hemodialysis and identify the microorganisms that are responsible for this by blood culture, through which we can decrease the intradialytic complications and costs of catheter changes and recurrent admission to hospital and ultimately patient survival on hemodialysis.

2. Materials and Methods

2.1. Ethical approval

The ethical considerations were implemented according Helsinki Declaration regarding ethical approval of Health authorities; ethical approval was taken from the Kurdistan Board Ethical Committee, informed written consent of patients, and management of catheter-related complications accordingly. A convenient sample of 100 patients with ESRDs on regular hemodialysis was selected after eligibility to inclusion and exclusion criteria.

2.2. Blood sample collection

The current study was a six-month cross-sectional study conducted at Erbil Teaching Hospital-Dialysis Unit in Erbil City, Kurdistan Region, Iraq, from January to Jun 2024. Ten ml blood specimens were gathered from each case and control group via central venous catheter. 5ml was transferred to a blood culture bottle (Microxpress, Spain) for cultivation, while the remaining 5ml was set in a gel tube and allowed to coagulate at ambient temperature (24°C) for fifteen minutes. The obtained samples were spun in a centrifuge at 3000 rpm for 10 minutes to isolate the serum.

2.3. Blood culture and media preparation

The blood culture was investigated in a Bio-Laboratory in Erbil city. This diagnostic equipment detects the presence of pathogens. A sterile needle and syringe will be used to collect the blood sample, which will then be transferred to the culture container. The BacT/ ALERT® 3D system (bioMeriéux, Marcy l'Etoile, France) was used for the initial investigation of blood cultures. Bacteria were collected and inoculated on Blood agar base (BAB, Himedia, India). This media is prepared by dissolving 40 gm of blood agar base in 1000 ml of D.W. After 20 minutes of autoclaving at 121 degrees Celsius, cool the medium to 45 degrees Celsius and add 5% fresh human blood. MacConkey agar plate (Oxoid, England) was prepared by mixing 40 grams of agar with 1000 ml of Distilled Water and sterilizing it in an autoclave at 121 degrees Celsius for 20 minutes [23].

2.4. Positive blood culture workflow

After receiving a positive signal from the BacT/ ALERT® 3D Device, Gram staining was performed. The bacteria were then cultivated on solid agar media. After overnight incubation, colonies on agar plates were identified and tested for antibiotic susceptibility (AST) using the commercial automated Vitek2 system (bioMeriéux). This technique supplied ID and AST values that served as a standard for comparing the institution's procedures.

2.5. Antibiotic susceptibility determination

Testing for antibiotic susceptibility was performed using Vitike 2 and the Disk Diffusion Method. Antibiotic susceptibility tests were performed on various isolates using the Clinical and Laboratory Standards Institute criteria [24]. Cells of bacteria were suspended, adjusted to a 0.5 McFarland standard tube, and distributed on Mueller Hinton agar (Himedia, India) using commercially available antibiotics (Bioanalyse, Turkey). Plates were then incubated at 37ºC for 18-24 hours. After incubation, antibiotic inhibition zone diameters (IZD) were measured in millimeters (mm) [25]. All isolated bacteria were evaluated for the creation of biofilm to detect antibiotic susceptibility. Nine antibiotics were employed, including ceftazidime (30 µg), erythromycin (15 µg), ampicillin (30 µg), ceftriaxone (30 µg), gentamicin (10 µg), cefotaxime (30 µg), vancomycin (30 µg), cefepime (30 µg), and methicillin (5 µg).

2.6. DNA extraction and 16S rDNA gene amplification

A DNA extraction kit (Geneaid Presto™Mini gDNA bacterial kit) was used for 100 samples to extract DNA from both gram-positive and gram-negative bacteria. The isolates of bacteria were later determined by amplifying the 16S rDNA gene via housekeeping primers (including 27 Forward= 5´- AGAGTTTGATCCTGGCTCAG -3´,1492 Reverese= 5´-GGTTACCTTGTTACGACTT -3´). The Polymerase Chain Reaction (PCR) reaction required 25 µl, 5 µl of each DNA template, 8 µl of nuclease-free water, 10 µl of Master mix, 1 µl forward, and 1 µl reverse primers. The PCR program was set up as follows: initial denaturation at 95°C for 5 mins, followed by 30 cycles of 95°C for 30 sec, 52°C for 30 sec, and 72°C for 1 min, followed by a final extension at 72°C for 5 mins. For sequencing, the PCR results were observed using agarose gel electrophoresis. Each sample had 20 µl of 16S rDNA PCR result labeled with the same number and delivered to Microgen organization.

When the DNA sequences returned from the company, they were trimmed and proofread. Subsequently, the Basic Local Alignment search tool (BLAST) in the National Center (https://www.ncbi.nlm.nih.gov/) for Biotechnology Information (NCBI) was used for identifying

bacterial species. After that, multiple sequence alignment was conducted by combining all of the rectified nucleotide sequences from the bacterial species. Then, using the maximum likelihood tool, the tree was constructed in Molecular Evolutionary Genetic Analysis (MEGA11; https://www.megasoftware.net/) to draw the phylogenetic tree of bacterial species.

2.7. Statistical analysis

Demographic and clinical data of cases were recorded. A part of the data collected was analyzed via GraphPad Prism version 10.2.3 and Others were analyzed statistically by Statistical Package of Social Sciences software version 22. Chi-square and Fisher's exact tests were applied. The findings were presented as OR and 95% CI, and a statistically significant P-value was defined as less than 0.05.

3. Results

3.1. General characteristics

One hundred cases participated in this study. P-value was deemed statistically significant at 0.001 for the largest percentage of hemodialysis patients in the current study, who were aged 60-69 years, compared to 26% of cases who were aged 50-59. Of the patients, 14% were younger than 40 years old, and 14% were between 40 and 49. Male gender patients were significantly higher than females. Regarding the body mass of hemodialysis patients, 28% of them were overweight. However, the smoking status of patients was categorized into; current (18%), no smoking (46%) and ex-smoking (36%). This study showed that those who ex-smoked significantly experienced hemodialysis, with *P* value=0.05. The past medical history of hemodialysis patients included hypertension (92%), diabetes mellitus (70%), peripheral vascular diseases (2%), autoimmune diseases (6%), cancer (6%) and history of immunosuppressive therapy (14%). A comprehensive summary of the general features and a quality assessment of the included studies are given in Table 1.

3.2. Hemodialysis characteristics

Table 2 offers comprehensive information on the included studies' hemodialysis characteristics and quality evaluation. This table showed that all catheters used for hemodialysis were also temporary. Regarding catheter number, 52% of patients had two catheters, 40% had three, 6% had four, and 2% had five. However, catheter insertion sites like femoral (20%, with OR= 0.3, 95%CI [0.1-1.2], *P*<0.048), and right subclavian (26%, with OR=0.8, 95%CI [0.1-3.2], *P*< 0.024) were significantly related with hemodialysis. Table 2 showed that 71% of cases experienced diabetes mellitus, which significantly increased the risk of hemodialysis (OR=6.3, 95%CI [0.3-10.4], *P*< 0.031). Moreover, 91% of patients were anemic (OR=7.1, 95%CI [0.6-8.2], *P*<0.003); the anemia was mild in 26% of them, moderate in 51% of them and severe in 22% of them.

3.3. Common bacterial infection in hemodialysis cases

A total of 44% of patients with a confirmed diagnosis of gram-negative bacteria (GNB) CABSI were diagnosed among 100%. Reduced immune response and body resistance in patients who have already experienced catheter-associated infections can make them more vulnerable to bacterial invasion and raise the risk of recurrent infections. Figure 1A demonstrates substantial differences (P<0.05) in bacterial types obtained from hemodialysis patients. Gram-negative bacteria were found in higher numbers than gram-positive bacteria. It was found that all bacteria were various and the three most widespread pathogens were *Staphylococcus epidermis* (44) with a percentage of (100%), followed by; *Pseudomonas aeruginosa* (29) with a percentage of (66%), and *Acinetobacter baumanni* (24) with a percentage of (55%) (Figure 1B).

3.4. Phylogenetic tree analysis of bacterial species using 16S rDNA gene

After recognizing and comparing 16S rDNA sequences to their type strains in NCBI database, the strain databases were uploaded to the Gene Bank available in the NCBI. A maximum likelihood tree was constructed using the 16S rDNA gene sequences of 13 bacteria types (Fig. 2). The tree was built using the MEGA 11 software. The tree shows the evolutionary relationship and distribution of (13) unique bacterial species collected from the hemodialysis unit as compared to reference strains. The tree revealed similarities between thirteen isolates.

3.5. Association between patient characteristics and catheter infection

Table 3 showed that no significant differences were

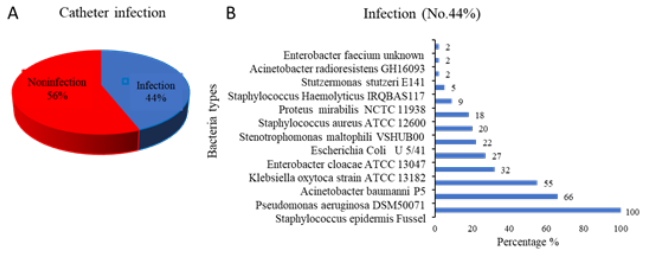

Fig. 1. Catheter Infection. **(A)** Infection and non-infection were shown**. (B)** Common species of bacteria in hemodialysis patients was shown.

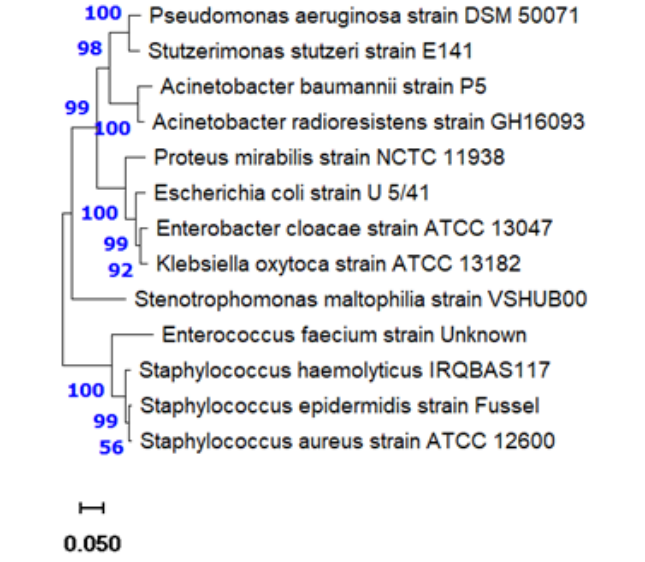

Fig. 2. Maximum likelihood tree constructed using 16S rDNA sequences of 13 isolated species. This tree illustrated their distribution and phylogenetic relationships isolated from the present study. Bootstrap values are present on the tree branch, 1000 replication.

Table 1. General characteristics of hemodialysis patients (n=100).

Variable	No. (%)	OR (95%CI)	*p. Value*
Age			
<40 years	14 (14.0)	0.5(0.3-1.4)	0.752
40-49 years	14 (14.0)	0.7(0.2-1.1)	0.929
50-59 years	26 (26.0)	0.6(0.1-1.7)	0.231
60-69 years	32 (32.0)	0.9(0.1-2.4)	0.001
≥70 years	14 (14.0)	0.4(0.1-1.1)	0.126
Gender			
Male	66 (66.0)	2.7(0.9-9.4)	0.032
Female	34 (34.0)	2.5(0.75-5.1)	0.123
BMI			
Normal	72 (72.0)	1.4(0.3-4.4)	0.262
Overweight	28 (28.0)	1.6(0.31-7.4)	0.512
Smoking status			
Current	18 (18.0)	0.3(0.1-1.1)	0.547
No smoking	46 (46.0)	1.5(0.32-7.3)	0.723
Ex-smoking	36 (36.0)	3.1(0.31-6.4)	0.05
Hypertension			
Yes	92 (92.0)	3.1(0.21-5.4)	0.02
No	8 (8.0)	0.2(01-1.4)	0.816
Diabetes mellitus			
Yes	70 (70.0)	6.3(0.3-10.4)	0.031
No	30 (30.0)	2.1(0.5-6.1)	0.363
PVD			
Yes	2 (2.0)	1.6(0.31-7.4)	0.427
No	98 (98.0)	1.6(0.31-7.4)	0.033
Autoimmune disease			
Yes	6 (6.0)	1.6(0.31-7.4)	0.661
No	94 (94.0)	2.1(0.4-8.1)	0.172
Cancer			
Yes	6 (6.0)	0.2(0.1-0.9)	0.713
No	94 (94.0)	5.1(0.9-9.8)	0.535
Immunosuppressive therapy			
Yes	14 (14.0)	0.6(0.1-1.4)	0.752
No	86 (86.0)	2.1(0.21-6.8)	0.001

BMI = Body mass index; Bold number = significant

Table 2. Hemodialysis characteristics.

Variable	No. (%)	OR (95%CI)	*P. Value*
Catheters number			
Two catheters	52 (52.0)	0.6(0.1-3.2)	0.012
Three catheters	40 (40.0)	0.2(0.1-1.2)	0.304
Four catheters	6 (6.0)	0.3(0.1-1.2)	0.524
Five catheters	2 (2.0)	0.1(0.1-0.9)	0.621
Catheters type			
Temporary	100 (100.0)	5.1(0.1-9.7)	0.632
Insertion site			
Femoral	20 (20.0)	0.3(0.1-1.2)	0.048
Right Internal Jugular	38 (38.0)	0.5(0.2-1.7)	0.072
Right Subclavian	26 (26.0)	0.8(0.1-3.2)	0.024
Left Internal Jugular	16 (16.0)	0.3(0.1-1.3)	0.826
Duration of dialysis			
<1 month	12 (12.0)	0.3(0.1-3.2)	0.253
1-3 months	60 (60.0)	0.1(0.1-3.2)	0.006
>3 months	28 (28.0)	0.4(0.1-3.2)	0.352
Duration of catheter			
<1 month	48 (48.0)	0.4(0.1-3.2)	0.521
≥1 month	52 (52.0)	0.1(0.1-1.01)	0.192
Catheter maneuvering>3 days			
Yes	34 (34.0)	0.2(0.1-1.2)	0.932
No	66 (66.0)	3.1(0.6-4.12)	0.36
Hospital stays			
<3 days	16 (16.0)	0.2(0.1-2.2)	0.462
≥3 days	84 (84.0)	4.7(0.1-5.2)	0.033
Hemoglobin level			
Normal	9 (9.0)	0.2(0.1-2.7)	0.06
Anemic	91 (91.0)	7.1(0.6-8.2)	0.003
Anemia severity			
Mild	26 (26.0)	0.3(0.1-5.2)	0,421
Moderate	51 (51.0)	0.1(0.1-1.9)	0.064
Severe	22 (22.0)	0.8(0.1-7.2)	0.071

Bold number; Significant

observed between hemodialysis patients with catheter infection and hemodialysis patients without catheter infection regarding age ($P< 0.1$), gender ($P < 0.6$), smoking status ($P < 0.7$), hypertension ($P< 0.7$), PVD ($P< 0.1$) and autoimmune diseases ($P< 0.2$). The mean BMI was significantly higher among hemodialysis patients with catheter infection ($P< 0.02$). There was a significant association between diabetes mellitus and hemodialysis patients with catheter infection ($P< 0.002$). The hemodialysis patients with cancer and immunosuppressive therapy were significantly associated with no catheter infection ($P< 0.02$, $P< 0.01$, respectively).

Table 4 revealed that there was a significant association between increased catheter number and catheter infection ($P< 0.01$). No significant differences were observed between hemodialysis patients with catheter infection and hemodialysis patients without catheter infection regarding insertion site ($P< 0.06$), catheter duration ($P< 0.7$) and hospital stay ($P< 0.1$). A significant association was observed between longer dialysis duration and catheter infection ($P< 0.02$). There was a significant association between catheter maneuvering>3 days and catheter infection ($P< 0.003$). The mean hemoglobin level was significantly lower among hemodialysis patients with catheter infection ($P< 0.05$). A significant association was observed between severe anemia and catheter infection (p=0.02).

4. Discussion

Many challenges are facing the national health care system in many countries due to the burden of increasing end-stage renal disease prevalence that is related to high morbidity and mortality rates [26]. Hemodialysis is an essential step in the management of thousands of patients with end-stage renal diseases. Venous catheter in hemodialysis has many advantages; although, it is accompanied by many complications like bloodstream infection, arthritis, endocarditis, and epidural abscess which lead to higher rates of mortality [27].

Table 3. Distribution of general characteristics according to catheter infection.

Variable	Catheter infection				*p. Value*
	Yes		No		
	No.	%	No.	%	
Age					0.1 NS
<40 years	6	(13.6)	8	(14.3)	
40-49 years	8	(18.2)	6	(10.7)	
50-59 years	14	(31.8)	12	(21.4)	
60-69 years	14	(31.8)	18	(32.1)	
≥70 years	2	(4.5)	12	(21.4)	
Gender					0.6 NS
Male	28	(63.6)	38	(67.9)	
Female	16	(36.4)	18	(32.1)	
BMI					**0.02** S
Mean±SD (Kg/m^2)	23.7±2.6		22.5±2.4		
Smoking status					0.7 NS
Current	8	(18.2)	10	(17.9)	
No smoking	22	(50.0)	24	(42.9)	
Ex-smoking	14	(31.8)	22	(39.3)	
Hypertension					0.7 NS
Yes	40	(90.9)	52	(92.9)	
No	4	(9.1)	4	(7.1)	
Diabetes mellitus					**0.002** S
Yes	38	(86.4)	32	(57.1)	
No	6	(13.6)	24	(42.9)	
PVD					0.1 NS
Yes	2	(4.5)	0	(-)	
No	42	(95.5)	56	(100.0)	
Autoimmune disease					0.2 NS
Yes	4	(9.1)	2	(3.6)	
No	40	(90.9)	54	(96.4)	
Cancer					**0.02** S
Yes	0	(-)	6	(10.7)	
No	44	(100.0)	50	(89.3)	
Immunosuppressive therapy					**0.01** S
Yes	2	(4.5)	12	(21.4)	
No	42	(95.5)	44	(78.6)	

BMI= Body mass index**;** S=Significant; NS=Not significant

The present study found that the prevalence of catheter-related bloodstream infection among hemodialysis patients in Erbil City was (44%). This prevalence is higher than the prevalence of hemodialysis catheter-related bloodstream infection (25%) reported by Jaudah and Musa cross-sectional study in Iraq on 80 patients with hemodialysis [28, 29]. Our study's prevalence of (44%) for catheter-related bloodstream infection is also higher than the results of Sahli et al study in Algeria which found that (20.3%) of hemodialysis patients had catheter-related infection[30]. Additionally, our study finding is higher than the results of Martin et al studies in Australia which reported that 17% of hemodialysis patients had catheter-related bloodstream infections [15]. This high prevalence of catheter-related bloodstream infection in our center might be attributed to many reasons such as poor health infrastructure, low hygiene culture of the community, and factors related to methodology and sample size. However, our study's prevalence of catheter-related bloodstream infection is lower than the prevalence of (58.6%) reported in Iraq [31] and the prevalence of (64%) reported in Iran [32]. A study conducted in the USA revealed that hemodialysis bloodstream infection rates differ regarding vascular access sites with a prevalence of (0.5%) for arteriovenous fistula, a prevalence of (0.9%) for arteriovenous graft, a prevalence of (4.2%) for long-duration central venous catheter and prevalence of (27.1%) for short duration central venous catheter in one month. Indeed, multicenter international surveys on seven thousand hemodialysis patients showed that catheter-related complications, in general, are detected commonly within the first three to six months following insertion of the catheter [33, 34].

In the current study, the common isolated pathogen was staphylococcus Epidermis (40%), followed by; staphylococcus Aureus (24%), E. Coli (10%), Klebsiella (10%) and Candida Sp. (6%). These findings are close to the results

Table 4. Distribution of hemodialysis characteristics according to catheter infection.

Variable	Catheter infection				*p. Value*
	Yes		No		
	No.	%	No.	%	
Catheters number					**0.01** S
Two catheters	20	(45.5)	32	(57.1)	
Three catheters	16	(36.4)	24	(42.9)	
Four catheters	6	(13.6)	0	(-)	
Five catheters	2	(4.5)	0	(-)	
Insertion site					0.06 NS
Femoral	12	(27.3)	8	(14.3)	
Right Internal Jugular	20	(45.5)	18	(32.1)	
Right Subclavian	8	(18.2)	18	(32.1)	
Left Internal Jugular	4	(9.1)	12	(21.4)	
Duration of dialysis					**0.02** S
<1 month	8	(18.2)	4	(7.1)	
1-3 months	20	(45.5)	40	(71.4)	
>3 months	16	(36.4)	12	(21.4)	
Duration of catheter					0.7 NS
<1 month	22	(50.0)	26	(46.4)	
≥1 month	22	(50.0)	30	(53.6)	
Catheter maneuvering>3 days					**0.003** S
Yes	22	(50.0)	12	(21.4)	
No	22	(50.0)	44	(78.6)	
Hospital stay					0.1 NS
<3 days	10	(22.7)	6	(10.7)	
≥3 days	34	(77.3)	50	(89.3)	
Hemoglobin					**0.05** S
Mean±SD (gm/dl)	9.1±1.3		9.7±1.3		
Anemia severity					**0.02** S
Mild	8	(20.0)	16	(31.4)	
Moderate	18	(45.0)	29	(56.9)	
Severe	14	(35.0)	6	(11.8)	

S=Significant, NS=Not significant.

of Farrington and Allon's study in USA [36] reported that main microorganism detected by culturing of catheter-related blood stream infection for hemodialysis patients was staphylococcus Epidermis followed by staphylococcus Aureus. Inconsistently, Altaee et al studies in Iraq reported the staphylococcus Aureus as the main isolated pathogen responsible for catheter-related infection among hemodialysis patients [35]. It was shown that gram-positive and coagulase-negative staphylococci are responsible for 40-80% of catheter-related bloodstream infections [36], while the gram-negative pathogens responsible for 20-40% of infections and polymicrobial and fungal pathogens represented 10-25% [37].

The present study's mean BMI was significantly higher among hemodialysis patients with catheter infection ($P< 0.02$). This finding is similar to reports of Soi et al studies in the USA which documented that obesity plays a major role in increasing the incidence of catheter-related bloodstream infection in hemodialysis. Our study showed a significant association between diabetes mellitus and hemodialysis patients with catheter infection ($P< 0.002$). This finding coincides with the results of Sahli et al study in Algeria which reported diabetes mellitus as a common risk factor for catheter-related bloodstream infection [30]. It was shown that elderly age, obesity, diabetes mellitus, and poor vasculature are the main reasons for higher rates of emergency hemodialysis [38]. The current study found that cancer and immunosuppressive therapy were significantly protective factors for catheter-related infection. This finding might be attributed to the fact that those patients received excessive care for catheters by health care staff than other patients.

In the current study, there was a significant association between increased catheter number and catheter-related infection ($P< 0.01$). Similarly, Shahar et al studies in Malaysia reported that multiple uses of catheters in hemodialysis increase the chance of catheter-related bloodstream infection [39]. Our study also showed a significant association between longer dialysis duration and catheter infection ($P< 0.02$). This finding is consistent with the results of Vidal et al study in Iraq which revealed that a longer duration of hemodialysis is accompanied by high rates of catheter-related infection. Our study found a significant association between catheter maneuvering>3 days and catheter-related bloodstream infection ($P< 0.003$) [40]. This finding coincides with the results of Knežević et al study in Serbia found that low hemoglobin levels and catheter maneuvering are the main risk factors for catheter-related

bloodstream infection [41]. In the present study, there was a significant association between anemia especially severe form, and catheter-related infection. Roberts et al study in the USA documented that anemia is prevalent among chronic renal disease patients on hemodialysis and is related to high catheter-related bloodstream infection rates [42].

4. Conclusion

The catheter-related bloodstream infections among hemodialysis patients in Erbil City were significantly influenced by obesity, diabetes mellitus, increased number of catheters, long duration of hemodialysis, catheter maneuvering, and severe anemia. The main pathogens for catheter-related infection were *Staphylococcus epidermis, Psedeumonas spp,* and *Acinetobacter spp*. The genera found had a close evolutionary relationship with each other. This study recommended improvement of the hygienic status of Erbil hospitals, an appropriate selection of insertion sites, better antiseptics, health and hygiene patients' education, infection surveillance, and specific care and monitoring of catheters.

Acknowledgments

Thanks to Assist. Prof. Dr. Sevan Omer Majed for analyzing 16S rDNA sequences and constructing phylogenetic analysis. He also thanks all medical and health staff working in Erbil Teaching Hospital-Dialysis Center for their efforts and help in completing my research.

Conflict of interest

The author declares that no patients were used in this study.

Availability of data and material

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Funding

None.

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