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Impact of Vascular Access Type on Inflammatory Biomarkers and Clinical Outcomes in Haemodialysis Patients

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ABSTRACT

Introduction: The majority of dialysis patients have chronic low-grade inflammation linked to protein energy waste, early CVD, osteoporosis, and overall weakness. To minimize the risk of infections and complications, guidelines advocate for the use of arteriovenous fistulas (AVFs) whenever possible, as central venous catheters (CVCs) pose a greater risk for these issues. **Objective:** This study aimed to assess the impact of various hemodialysis vascular access types on the occurrence and characteristics of infections experienced by hemodialysis patients.

Patients and Methods: This prospective cohort study was conducted in Ain Shams University Hospitals, Hemodialysis Units over 6 months duration. **Results:** We found that the average age of the patients was 49.5 ± 8.4 years and the average duration of hemodialysis (HD) was 3.2 ± 1.9 years. The proportion of males and females was nearly equal (46.0% and 54.0% respectively). Patients from El-Demerdash and ASHUSH accounted for 60.3% and 39.7% of the cases, respectively. Catheter types included temporary catheters (49.2%), AVFs (31.7%), and AVGs (19.0%). We noticed that less than one-fifth of cases had leucocytosis and elevated procalcitonin in months 2 and 3. Leucocytosis and elevated procalcitonin in months 2 and 3 were most frequent in temporary catheters, followed by AVGs, and least frequent in AVFs. **Conclusion:** The use of temporary catheters was linked to a higher incidence of infections. Infection episodes were accompanied by elevated inflammatory markers, a higher likelihood of catheter removal, an increased risk of thrombosis, and more frequent hospital admissions.

Keywords: Vascular access, Inflammatory biomarkers, Clinical outcomes, Haemodialysis.

INTRODUCTION

For individuals with end stage renal disease, hemodialysis (HD) is a life-sustaining therapy that offers hope for survival. For long-term dialysis patients to extend their lives, it is essential to establish and maintain a functioning permanent vascular access [1-3]. Arteriovenous grafts (AVGs), natural arteriovenous fistulas (AVFs), and central venous catheters (CVCs), which come in both tunneled and non-tunneled varieties, are the three primary alternatives for vascular access available to HD patients. One of the main obstacles to the widespread adoption of CVCs is catheter-related bloodstream infections (CRBSIs). Cardiovascular disease is the primary cause of mortality for patients on HD, with CRBSIs coming in second. Exit-site infections, tunnel infections, and CRBSIs are the three different categories of CVC-related infections. CRBSIs are a leading cause of hospitalization and mortality in patients receiving hemodialysis among these [4]. Incidence rates of CRBSIs for temporary CVCs vary from 3.25 to 10.8 episodes per 1,000 catheter days, while for permanent CVCs they range from 0.55 to 4.4 episodes per 1,000 catheter days. It is essential to comprehend the risk factors for CRBSIs in order to put preventive measures into place. Compared to patients getting HD via AVF or AVG, those receiving HD through CVCs are more likely to experience a bloodstream infection. Moreover, a history of prior catheter-related bacteraemia, low serum albumin levels, diabetes mellitus, advanced age, low haemoglobin levels, and extended CVC usage have all been associated with an elevated risk of bloodstream infection [5]. Gram-positive bacteria, particularly Staphylococcus aureus and coagulase-negative staphylococci, are the most common causes of CRBSIs, accounting for up to 80% of infections. Gram-negative bacteria such Pseudomonas aeruginosa, Escherichia coli, and Klebsiella pneumoniae account for the remaining 20% of CRBSIs [6].

This study aimed to examine the influence of different vascular access types on the risk of infection (overt, occult infections, microbial infection patterns, antibiotic responsiveness, and clinical outcomes) in maintenance HD patients.

PATIENTS AND METHODS

The current study was a prospective cohort on maintenance HD patients (63) from the HD Units at Ain Shams University Hospitals, Cairo, Egypt. This study was conducted through the period from December 2022 to March 2023.

Inclusion criteria: Age at least 18 years old and received maintenance HD for at least 6 months.

Exclusion criteria: Patients who refused the participation in the study, acute kidney injury (AKI) patients, the primary vascular access creation was not within the study period, removal date could not be verified and patients with malignancy or those with coexistence of infective sources other than vascular access.

All participants subjected to the following: A thorough assessment was conducted, encompassing A detailed medical history, including personal details, past medical conditions, past surgical procedures, medications taken, underlying cause of kidney failure, duration of dialysis, and specific information about the vascular access (type, location, and date of creation). A

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comprehensive clinical examination, including the recording of vital signs, a thorough general examination, body mass index (BMI) measurement, dry weight determination, and a meticulous evaluation of the vascular access, particularly focusing on signs of inflammation and clinical manifestations of access infection, which may include:

Fever, chills, and exit site infection. However, other signs and symptoms may also occur, including:

- Hemodynamic instability: This refers to changes in blood pressure, heart rate, and breathing that can be caused by infection.
- Altered mental status: This includes confusion, disorientation, and drowsiness.
- Access dysfunction: This means that the vascular access is not working properly, and the patient may not be able to receive dialysis.
- Other signs of sepsis: include hypothermia, acidosis and hypotension.
- Signs and symptoms of exit site infection
- Redness, swelling, or tenderness around the exit site.
- Drainage of pus or fluid from the exit site.
- Pain or discomfort around the exit site.

Also, laboratory investigations were done in the form of:

Complete blood picture (CBC), high sensitivity C-reactive protein (HsCRP), procalcitonin and blood culture from suspected sepsis patients (two samples; one from access site and another from a peripheral vein). AST, ALT, serum albumin and electrolytes were collected monthly from the studied population. Also, Echocardiography was done (for possible presence of vegetations).

To confirm the diagnosis of infected vascular access, two blood cultures were collected before initiating antibiotic therapy, and any other potential sources of infection were ruled out. The timing of blood culture collection varied according to the development of symptoms in relation to the dialysis procedure:

- Patients with symptoms emerging immediately before their next HD session (e.g., within a few hours), supply one blood culture from the HD catheter and another from either a peripheral vein or the HD circuit bloodstream during dialysis for testing.
- Patients developing symptoms or indicators of bloodstream infection during HD therapy gave two samples from the HD circuit bloodline or one from the circuit bloodline and a peripheral vein.
- Patients developing symptoms or indications of bloodstream infection during the 48 to72 hour interdialytic interval, but not within a few hours of their next HD session, were asked to produce two samples: one from the HD catheter and one from their peripheral vein. Alternatively, two samples could be drawn from peripheral veins.

  Patients were followed for 4 months, and sepsis markers, including total leukocyte count (TLC), HsCRP, procalcitonin, AST, ALT, serum albumin, and blood cultures from suspected patients were tested and documented.

Ethical approval: The Ethics Committee of Faculty of Medicine, Ain Shams University granted the study approval (FWA000017585). All participants signed informed consents after a thorough explanation of the goals of the study. The Helsinki Declaration was followed throughout the study's conduct.

Statistical analysis

Codes, tabulations, and computer input using SPSS V. 20.0 were all part of the rigorous evaluation process that was applied to the collected data. Each parameter's data type was taken into consideration while presenting the data and doing the appropriate statistical analysis. Range and mean ± SD were found for parametric numerical data. Calculations were made for percentage and frequency of non-numerical data. The independent-sample t-test was utilised to assess the statistical significance of the variation between the independent means of two research groups about a parametric variable. To determine if two category variables were related, the chi-square test was employed. As an alternative, Fisher's exact test was utilised when the predicted count was less than 5 in more than 20% of the cells. A significant p-value was defined as ≤ 0.05.

RESULTS

Patient characteristics: Patient recruitment for this study involved enrolling individuals on maintenance hemodialysis from various units within Ain Shams University HD hospitals. However, due to the limited sample size within the tunneled permanent catheter group (four patients in Demerdash HD unit and three in Ain Shams University Specialized Hospital), these participants were excluded to maintain robust statistical analysis. After applying our inclusion criteria, a final sample size of 63 patients was included in the study. Our study population consisted of 63 hemodialysis patients with an average age of 49.5 ± 8.4 years and a mean hemodialysis duration of 3.2 ± 1.9 years. The group was nearly evenly distributed between genders (46.0% males and 54.0% females). Slightly over half (60.3%) received hemodialysis treatment at Demerdash Hospital, while the remaining 39.7% were treated at Ain Shams University Specialized Hospital. Regarding vascular access, the majority (49.2%) relied on temporary catheters, followed by arteriovenous fistulas (AVFs) at 31.7% and arteriovenous grafts (AVGs) at 19.0%. Notably, hypertension and diabetes were the most prevalent co-morbidities among the participants. Figure (1) showed that fever was the most frequent complication (28.6%), followed by peripheral positive culture (25.4%), then access positive culture (19.0%). 19% of patients had leucocytosis and 12.7% had elevated procalcitonin in months 2 and 3, respectively.

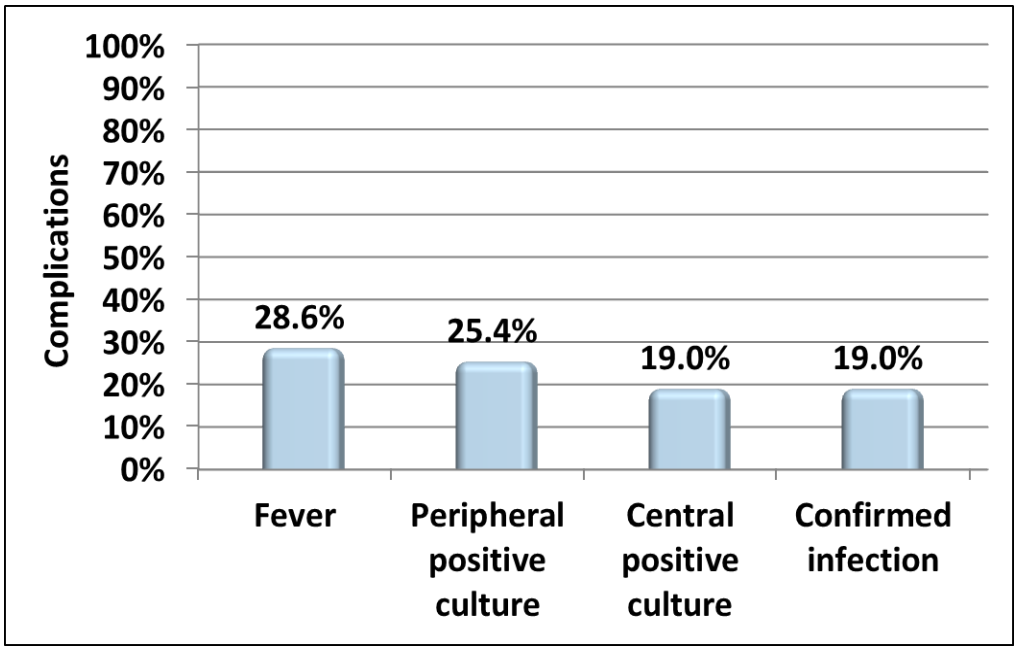

Figure (1): Complications among the studied cases

Analysis of inflammatory markers demonstrated a clear trend across vascular access types. Patients with temporary catheters exhibited the highest frequency of leucocytosis and elevated procalcitonin levels in months 2 and 3, followed by those with arteriovenous grafts (AVGs) and subsequently, arteriovenous fistulas (AVFs). Notably, leucocytosis differences between the groups were statistically significant in both months 2 and 3. Similarly, elevated high-sensitivity C-reactive protein (HsCRP) occurred most frequently in temporary catheter patients across all three months, followed by AVG and AVF, with significant differences observed in all months. However, elevated alanine transaminase (ALT) occurred most frequently in temporary catheter patients only in month 3, with significant differences detected only in this month (Table 1).

Table (1): Laboratory findings in patients with different types of vascular access

Time	Temporary catheter (Total=31)	AVF (Total=20)	AVG (Total=12)	p-value
Leucocytosis				
Month-2	10 (32.3%) a	0 (0.0%) b	2 (16.7%) ab	**§0.007***
Month-3	11 (35.5%) a	0 (0.0%) b	2 (16.7%) ab	**§0.007***
Elevated procalcitonin				
Month-2	6 (19.4%)	0 (0.0%)	2 (16.7%)	§0.096
Month-3	6 (19.4%)	0 (0.0%)	2 (16.7%)	§0.096
HsCRP (gm/dL)				
Baseline	3.0 (2.0–4.0)	3.0 (2.0–5.0)	3.0 (2.0–4.0)	^0.905
Month-1	5.0 (3.0–15.0) a	3.0 (2.0–4.0) b	3.0 (2.0–5.0) ab	**^0.001***
Month-2	5.0 (4.0–23.0) a	3.0 (2.0–5.0) b	3.5 (3.0–6.0) ab	**^0.006***
Month-3	7.0 (4.0–24.0) a	3.0 (2.0–4.0) b	3.0 (2.0–8.5) b	**^<0.000***
ALT (IU/L)				
Baseline	23.0 (14.0–32.0)	22.5 (16.0–29.5)	27.0 (20.0–34.0)	^0.589
Month-1	21.0 (15.0–25.0)	21.0 (16.0–25.5)	26.5 (20.5–30.5)	^0.184
Month-2	21.0 (15.0–26.0)	22.0 (18.0–31.0)	20.5 (15.5–24.0)	^0.508
Month-3	32.0 (25.0–41.0) a	22.5 (20.5–28.0) b	25.5 (20.5–31.0) b	**^0.003***

^Kruskall Wallis test. §Fisher's Exact test. *Significant. Homogenous groups had the same symbol "a, b" based on Post Hoc Bonferroni test.

Analysis of complication frequency across vascular access types revealed a tendency for temporary catheters to be associated with the highest rates, followed by AVGs and then AVFs. However, these differences were not statistically significant (Table 2).

Table (2): The incidence of complications in the different access types

Complications	Temporary catheter (Total=31)	AVF (Total=20)	AVG (Total=12)	p-value
Fever	13 (41.9%)	3 (15.0%)	2 (16.7%)	#0.069
Peripheral positive culture	11 (35.5%)	3 (15.0%)	2 (16.7%)	#0.193
Central positive culture	9 (29.0%)	1 (5.0%)	2 (16.7%)	§0.098
Confirmed infection	9 (29.0%)	1 (5.0%)	2 (16.7%)	§0.098
Relative risks (95% confidence interval)				
	Temporary catheter Vs. AVF	**Temporary catheter Vs. AVG**	**AVF Vs. AVG**	
Fever	2.80 (0.91–8.59)	2.52 (0.66–9.53)	0.90 (0.17–4.64)	
Peripheral positive culture	2.37 (0.75–7.44)	2.13 (0.55–8.22)	0.90 (0.17–4.64)	
Central positive culture	5.81 (0.80–42.39)	1.74 (0.44–6.92)	0.30 (0.03–2.97)	
Confirmed infection	5.81 (0.80–42.39)	1.74 (0.44–6.92)	0.30 (0.03–2.97)	

#Chi square test. §Fisher's Exact test

Among patients with temporary catheters, peripheral blood cultures revealed a predominance of staphylococci and enterococci (36.4% each), followed by candida (27.3%), although this trend was not statistically significant compared to other vascular access types. Notably, catheter-related infections displayed a slightly higher susceptibility to vancomycin and teicoplanin compared to other access types, albeit statistically insignificant. Importantly, carbapenem resistance was uniquely observed in patients with temporary catheters, highlighting a potential risk factor for this antibiotic class (Table 3).

Table (3): Peripheral blood culture results in patients with different vascular access types

Variables		Temporary catheter (Total=11)	AVF (Total=3)	AVG (Total=2)	p-value
Organism	**Staphylococci**	4 (36.4%)	0 (0.0%)	0 (0.0%)	§0.728
	Enterococci	4 (36.4%)	0 (0.0%)	0 (0.0%)	§0.728
	Klebsiella	0 (0.0%)	0 (0.0%)	1 (50.0%)	§0.125
	Acinetobacter	0 (0.0%)	0 (0.0%)	1 (50.0%)	§0.125
	Pseudomonas	0 (0.0%)	1 (33.3%)	0 (0.0%)	§0.312
	Candida	3 (27.3%)	2 (66.7%)	0 (0.0%)	§0.396
Antibiotic sensitivity	**Vancomycin**	4 (36.4%)	0 (0.0%)	0 (0.0%)	§0.728
	Linezolid	7 (63.6%)	0 (0.0%)	0 (0.0%)	§0.091
	Tieman	0 (0.0%)	1 (33.3%)	1 (50.0%)	§0.083
	Tetracycline	1 (9.1%)	0 (0.0%)	0 (0.0%)	§0.999
	Quinolones	1 (9.1%)	0 (0.0%)	0 (0.0%)	§0.999
	Colistin	0 (0.0%)	0 (0.0%)	1 (50.0%)	§0.125
	Teicoplanin	4 (36.4%)	0 (0.0%)	0 (0.0%)	§0.728
Antibiotic resistance	**Carbapenem**	8 (72.7%) a	0 (0.0%) b	0 (0.0%) b	**§0.026***
	Cephalosporine	0 (0.0%) a	1(33.3%)	0 (0.0%) a	§0.312
	Penicillin	0 (0.0%) a	1(33.3%)	0 (0.0%) a	§0.312
	MDR	0 (0.0%) a	1(33.3%)	0 (0.0%) a	§0.312

§Fisher's Exact test. *Significant. Homogeneous groups had the same symbol "a, b" based on post hoc Bonferroni test

Analysis of vascular access cultures revealed a predominance of staphylococci (55.6%) and enterococci (22.2%) in patients with temporary catheters, followed by klebsiella and candida (11.1% each). While this trend showed higher rates for staphylococci and enterococci compared to other access types, statistical significance was not achieved. Interestingly, catheter-related infections displayed slightly higher susceptibility to vancomycin (55.6%), linezolid (66.7%), and teicoplanin (22.2%) compared to other access types, but these differences were not statistically significant. Importantly, carbapenem resistance was uniquely observed in patients with temporary catheters, highlighting a potential risk factor associated with this access type (Table 4).

Table (4): Access culture results in different access types

Variables		Temporary catheter (Total=9)	AVF (Total=1)	AVG (Total=2)	p-value
Organism	**Staphylococci**	5 (55.6%)	0 (0.0%)	0 (0.0%)	§0.470
	Enterococci	2 (22.2%)	0 (0.0%)	0 (0.0%)	§0.999
	Klebsiella	1 (11.1%)	0 (0.0%)	1 (50.0%)	§0.455
	Acinetobacter	0 (0.0%)	0 (0.0%)	1 (50.0%)	§0.250
	Pseudomonas	0 (0.0%)	1 (100%)	0 (0.0%)	§0.083
	Candida	1 (11.1%)	0 (0.0%)	0 (0.0%)	§0.999
Antibiotic sensitivity	**Vancomycin**	5 (55.6%)	0 (0.0%)	0 (0.0%)	§0.470
	Linezolid	6 (66.7%)	0 (0.0%)	0 (0.0%)	§0.182
	Tieman	0 (0.0%)	1 (100%)	0 (0.0%)	§0.083
	Tetracycline	2 (22.2%)	0 (0.0%)	0 (0.0%)	§0.999
	Quinolones	1 (11.1%)	0 (0.0%)	0 (0.0%)	§0.999
	Colistin	0 (0.0%)	0 (0.0%)	1 (50.0%)	§0.250
	Teicoplanin	2 (22.2%)	0 (0.0%)	0 (0.0%)	§0.999
Antibiotic resistance	**Carbapenem**	7 (77.8%) a	0 (0.0%) b	0 (0.0%) b	**§0.045***
	Cephalosporine	0 (0.0%)	1 (100%)	0 (0.0%)	§0.083
	Penicillin	0 (0.0%)	1 (100%)	0 (0.0%)	§0.083
	MDR	1 (11.1%)	0 (0.0%)	0 (0.0%)	§0.999

§Fisher's Exact test. *****Significant. Homogeneous groups had the same symbol **"a,b"** based on post hoc Bonferroni test

Figure (2) showed that the incidence of catheter removal, access thrombosis, hospitalization, and mortality were 14.3%, 1.6%, 7.9% and 4.8% of the studied cases respectively.

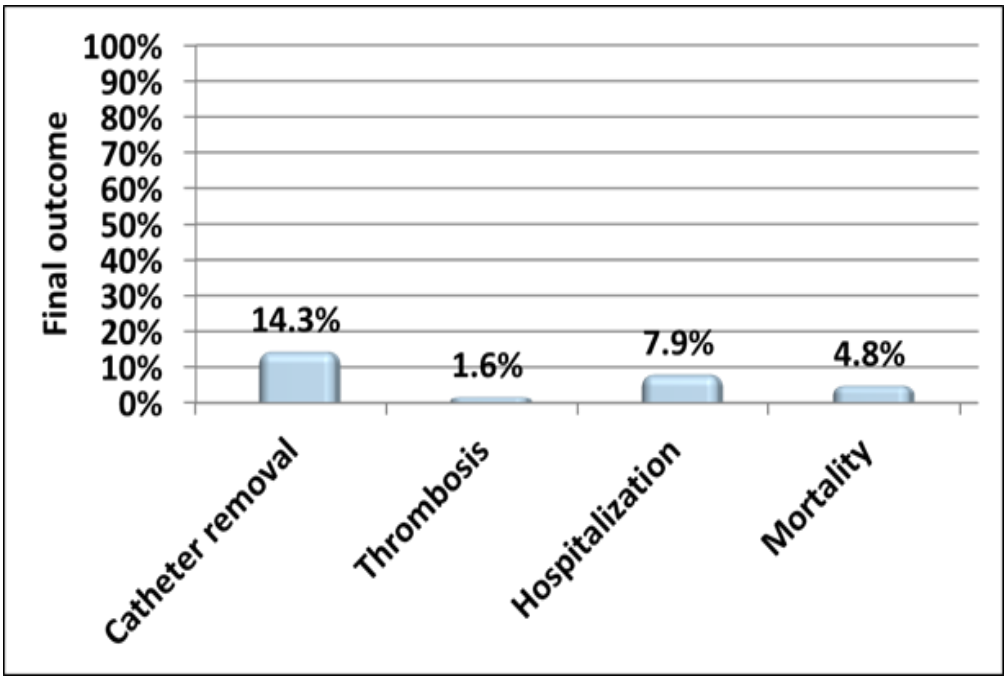

Figure (2): Outcome of infected cases.

Our study revealed a significant association between longer durations of temporary catheter use and the occurrence of fever, positive peripheral blood cultures, and positive access site cultures (Table 5).

Table (5): Relations between presence of fever, positive peripheral, or central cultures in temporary catheter infection episodes and duration of use of catheters:

Variables	Fever		Peripheral culture		Central culture	
	Positive (Total=13)	Negative (Total=18)	Positive (Total=11)	Negative (Total=20)	Positive (Total=9)	Negative (Total=22)
Duration of use (weeks)	4.5±2.1	2.6±1.3	5.1±1.8	2.5±1.3	4.9±1.9	2.8±1.6
p-value	^0.008*		<0.001*		^0.004*	

^Independent t-test. §Fisher's Exact test. *Significant

Table (6): Comparison according to catheter type regarding outcomes

Variables	Temporary catheter (Total=31)	AVF (Total=20)	AVG (Total=12)	p-value
Removal	9 (29.0%)			
Thrombosis	0 (0.0%)	0 (0.0%)	1 (8.3%)	§0.190
Hospitalization	4 (12.9%)	0 (0.0%)	1 (8.3%)	§0.206
Mortality	2 (6.5%)	0 (0.0%)	1 (8.3%)	§0.430
Relative risks (95% confidence interval)				

DISCUSSION

The participants in the study had an average age of 49.5 ± 8.4 years. The average duration of HD therapy was 3.2 ± 1.9 years. The gender distribution was almost equal, with 46.0% of the participants being males and 54.0% being females. Over half (60.3%) of the participants were recruited from Demerdash General Hospital, while the remaining 39.7% were recruited from Ain Sham University Specialized Hospital (ASUSH) dialysis units.

The utilization of temporary catheters as the primary vascular access among study participants (49.2%) stands in contrast to the current KDOQI guidelines, which advocate for the prioritization of AVFs 31.7% and AVGs 19% over temporary catheters for incident HD patients. This deviation from the recommended guidelines highlights the need to encourage and facilitate the transition from temporary catheters to more permanent and infection-risk-mitigating vascular access options, such as AVFs and AVGs, among HD patients.

In our study, the optimal location for CVC insertion was shown to be the right internal jugular vein, accounting for 41.9% of placements, followed by the right subclavian vein (25.8%), left internal jugular vein (22.6%), and left subclavian vein (9.7%). Leukocytosis and elevated procalcitonin levels were more commonly observed in CVC patients during months 2 and 3 compared to AVG patients, with the lowest incidence among AVF patients. The disparity in leukocytosis rates was statistically significant. Consistent with our findings, previous studies have reported similar trends. **Alshahat *et al.*** [7] studied 720 HD patients with end-stage renal disease to determine the frequency of vascular access infection, identify related risk factors, characterise the common pathogenic bacteria, and test antibiotic susceptibility. The study found a vascular access infection frequency of 27.77%, with temporary catheters having the greatest infection rate. Gram-positive bacteria were the most common causal agents, accounting for 57.5% of cases, followed by Gram-negative bacteria (39.5%) and Candida albicans (3%). Amikacin and imipenem exhibited the strongest antibiotic efficacy. In a study conducted by **Kazakova *et al.*** [8], 2352 participants were evaluated, with 1,870 (79.5%) initiating HD via a CVC, 77 (3.3%) using a graft, and 405 (17.2%) employing a fistula. During the first year, the incidence of BSI hospitalization per 1,000 person-days was significantly lower for patients initiating HD with a fistula (0.3) compared to those using a CVC (1.3) or graft (0.8) (P<0.001). After adjusting for confounding factors, incident fistula use was associated with 61% reduced risk of BSI (HR, 0.39; 95% CI, 0.28-0.54; P<0.001) compared to incident CVC or graft use. Similarly, prevalent fistula or graft use exhibited a lower risk of BSI compared to prevalent CVC use (HRs of 0.30 [95% CI, 0.22-0.42] and 0.47 [95% CI, 0.31-0.73] respectively). These findings corroborate our study's results.

In the current study, patients with confirmed bloodstream infection, had a peripheral positive culture (25.4%), fever (28.6%) and the most common causative organisms were staphylococci and enterococci with vancomycin and linezolid sensitivity respectively, while only 4 cases had MDR strains. According to a study by **Sahli *et al.*** [9], 94 patients were analyzed for identifying CVC-related infection risk factors and causative micro-organisms. Results showed that staphylococcus aureus accounted for 23.5%, Acinetobacter baumannii, 8.8%, Stenotrophomonas maltophilia, 5.8%, Candida spp, 5.8%, E. coli, 2.9%, and Proteus mirabilis, 2.9%. **Bhojaraja *et al.*** [10] conducted a study that align with our findings, The study involved 921 catheters used by 882 hemodialysis patients. Median catheter duration

was 40 days, 23% of catheters (in 882 patients) developed CRBSI, with more being culture-negative (67.5%) than culture-positive (32.5%). Risk factors: Age under 60, male sex, diabetes, leukocytosis, and positive procalcitonin. Mostly uncuffed and jugular. CRBSI incidence: 13.39 per 1000 catheter days. Median time to CRBSI: 17.2 days. Salvage rate: 19.3%. Exit site infection rate: 19.8%. Common pathogens: Gram-positive CoNS and ESBL-producing enteric Gram-negatives and mortality rate was 6.6%.

In their study, **Ibrahim *et al.*** [(11)] explored the association between CVC dwell time and the prevalence of CRBSI in 45 HD patients. They followed patients with CVCs inserted for more than 48 hours and found a high CRBSI rate of 42.5% among their HD population. Catheterization duration differed significantly between the two study groups. Patients with CRBSI demonstrated markedly elevated TLC and CRP levels compared to those without CRBSI. A positive correlation was established between CRP levels and both catheter duration and TLC. Staphylococcus aureus emerged as the most prevalent isolated organism, and vancomycin was the most frequently administered antibiotic among infected patients.

Our study revealed that catheter removal, thrombosis, hospitalization, and mortality occurred in 14.3%, 1.6%, 7.9%, and 4.8% of cases respectively. Hospitalization rates were highest among patients with temporary catheters, followed by those with AVGs and lowest among those with AVFs. The incidence of thrombosis was highest in AVG patients, and mortality highest in temporary catheter patients followed by AVG patients. These findings align with those of **Ng *et al.*** [(12)], who reported that at baseline, 22% of the 2635 incident patients had a graft, 18% had a fistula, and 60% were dialyzing with a catheter. Baseline catheter usage (adjusted relative risk [RR] = 1.30, 95% confidence interval (CI: 1.09–1.54) was linked to an increased risk of all-causes of hospitalization compared to fistulae. However, graft use (RR = 1.07, 95% CI: 0.89–1.28) did not show any association with an elevated risk. When accounting for variations in VA over time, the risk of using a catheter as opposed to a fistula was greater (RR = 1.72, 95% CI: 1.42–2.08) and somewhat higher (RR = 1.15, 95% CI: 0.94–1.41). The strongest correlation between baseline catheter usage and infection was seen. Consistent with our study's findings**, Perl *et al.*** [(13)] conducted a study involving 40,526 incident adult dialysis patients and found that the one-year mortality rate was similar for patients with arteriovenous fistula or graft (AVF/AVG) access compared to those with peritoneal dialysis (PD), but it was significantly higher for patients with CVCs. The mortality rates depending on baseline vascular access types were 59.6, 96.4, and 181.6 per 1,000 person-years for AVF/AVG alone, AVF/AVG + catheter, and catheter only respectively. Patients with catheter-only access exhibited a considerably greater death rate than those with AVF/AVG-only or AVF/AVG + catheter access. Furthermore, individuals with AVF/AVG + catheter access died at a considerably greater incidence than those with AVF/AVG-only access. In addition to vascular access types, age, hsCRP levels, diabetes mellitus, albumin levels, and AST/ALT levels all had a substantial impact on overall mortality rates.

Our study demonstrated that temporary catheter patients had the highest HsCRP levels in months 1, 2, and 3, and the highest ALT levels in month 3, followed by AVG patients, and the lowest levels were observed in AVF patients. The difference in HsCRP levels between temporary catheter patients and AVF patients was statistically significant in months 1 and 2, but not in month 3. While base line albumin level and follow up didn't show any significant differences. Adeniyi **and Tzamaloukas** [(14)] conducted a study on 87 chronic HD patients who were hospitalized for an HD access-related infection. They compared the pre-infection blood albumin levels of 79 patients with HD access infection to those of 198 control patients with chronic HD who were admitted to the hospital at the same time for other reasons. Their data indicated that hypoalbuminemia was linked to an increased risk of HD access infection. Preadmission serum albumin levels were considerably lower in the HD access infection group (2.4 ± 0.6 g/dL) compared to the control group (3.2 ± 0.6 g/dL, $P<0.0001$). Logistic regression research revealed that pre-admission serum albumin levels were a strong independent predictor of HD access infection. Borderline serum albumin values (3-3.2 g/dl) were seen in our entire research sample.

On average, temporary catheters remained in place for 3.4 ± 1 weeks in our study. Patients with positive peripheral cultures had significantly longer temporary catheter durations compared to those with negative cultures. The location of the temporary catheter access site did not significantly influence peripheral culture findings. Additionally, temporary catheter duration was significantly longer in patients with bacteremia. **Fernández-Lucas *et al.*** [(15)] reported similar findings, with 318 additional catheter sites being implanted, and the catheters being in place for a total of 6,235 days. After three weeks after insertion in the internal jugular vein, the incidence of bacteremia was 5.4%, and after one week in the femoral vein, it was 10.7%. The incidence of bacteremia rose from 1.9% on the first day following the start of an exit-site infection to 13.4% on the second day if the catheter was left in place. Guidewire replacement for patient-related issues or malfunctions had no discernible impact on the likelihood of bacteremia.

CONCLUSION

The use of temporary catheters was linked to a higher incidence of infections. Infection episodes were accompanied by elevated inflammatory markers, a

higher likelihood of catheter removal and more frequent hospital admissions.

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