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Bacterial Infections in Hemodialysis Patients: A Cross-sectional study on associated risk factors and Antibiotic Susceptibility Pattern at a Tertiary Care Center in South-East Rajasthan

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ABSTRACT

Background: Hemodialysis is the principal renal replacement therapy for end-stage renal disease, but infectious complications remain the leading cause of hospitalization and the second leading cause of mortality after cardiovascular events. Fever is a common manifestation, often associated with vascular access infections, urinary tract infections, and respiratory infections. The emergence of multidrug-resistant organisms further complicates management. This study aimed to determine the spectrum of bacterial pathogens, their antimicrobial resistance patterns, and risk factors for infection among hemodialysis patients at a tertiary care centre in South-East Rajasthan.

Materials & Methods: This cross-sectional hospital-based study was conducted in the Department of Microbiology from June 2023 to May 2024. A total of 150 consented hemodialysis patients who developed fever after dialysis were included. Patients with pre-dialysis fever or prior positive cultures were excluded. Clinical specimens including catheter tips, blood, urine, sputum, and pus were processed by standard microbiological methods. Antibiotic susceptibility testing was performed by Kirby-Bauer disk diffusion as per CLSI guidelines. Vancomycin susceptibility was tested by screen agar and colistin by broth microdilution. P-value <0.05 was considered as statistical significance.

Results: Among 150 patients, 54.6% were >50 years and 62.7% were males. Hypertension [63.3%], catheterization >14 days [63.3%], and diabetes [48%], were major risk factors. Culture positivity was highest from catheter tips [46.7%], followed by sputum [46.2%] and urine [45%]. Catheter-related bloodstream infection was seen in 21.3% and catheter-related infection in 25.3%. Staphylococcus aureus was the predominant isolate from catheter tip [32.9%] and blood [34.4%], E. coli from urine [55.6%], and P. aeruginosa from sputum [58.3%]. MRSA ranged from 65.2% to 100% but all Gram-positive isolates were sensitive to linezolid and vancomycin. Gram-negative isolates showed highest susceptibility to colistin [100%] and imipenem.

Conclusion: Catheter-related infections predominate as cause of fever in hemodialysis patients, with Staphylococcus aureus as the leading pathogen and high MRSA burden. Regular microbiological surveillance, strict infection control, and colistin and linezolid-based empirical protocols are essential to reduce morbidity and combat multidrug resistance.

Keywords: *Hemodialysis, Catheter-related bloodstream infection, MRSA, Multidrug resistance, Fever, End-stage renal disease.*

INTRODUCTION

Hemodialysis is the principal renal replacement therapy for patients with end-stage renal disease (ESRD) and remains a life-sustaining treatment until transplantation. Despite its therapeutic benefits, it is associated with multiple complications, among which infections are the leading cause of hospitalization and the second most common cause of morbidity and mortality after cardiovascular disease.[1] Infection-related mortality in dialysis patients is significantly higher than in the general population due to immune dysfunction, repeated healthcare exposure, and invasive procedures.[2]

Fever is a frequent manifestation of infection in hemodialysis patients, commonly arising from bronchopulmonary infections, urinary tract infections, and vascular access-related infections.[3,] Gram-positive cocci, Gram-negative bacilli, and Streptococcus spp. are the predominant pathogens.[4] Furthermore, increasing antibiotic Resistance is a significant threat that results in emergence of Multidrug Resistant Organisms (MDRO) which complicates the management of these infections, resulting in adverse clinical outcomes.[5]

With the rising burden of chronic kidney disease, infectious complications in hemodialysis patients contribute substantially to morbidity, mortality, and healthcare costs. Understanding the local etiological profile, antimicrobial susceptibility patterns, and associated risk factors is essential for guiding empirical therapy, strengthening antimicrobial stewardship, and improving patient outcomes.[6,7]

The present study was undertaken to determine the spectrum of locally prevalent bacterial pathogens, evaluate their antimicrobial resistance patterns, and identify risk factors for infection among patients undergoing hemodialysis at a tertiary care centre in South-East Rajasthan.

MATERIALS & METHODS

This Cross-sectional hospital-based study was conducted in the Department of Microbiology at a tertiary care center from June 2023 to May 2024. All consented patients who developed fever with or without chills, headache, hypotension, or inflammation at central venous catheter insertion sites (jugular, femoral, subclavian) after dialysis were included. Patients with pre-dialysis fever or inflammation, positive blood cultures prior to dialysis, or those unwilling to participate were excluded.

Data was collected using a pretested structured questionnaire including socioeconomical details and patient medical data such as name, age, sex, address, date of admission, clinical data like chief complaints, personal history, past medical history, high risk factors, immunocompromised status, physical examination findings and details of clinical diagnosis of patients, indication for hemodialysis.

Relevant clinical specimens including dialysis catheter tips, blood, urine, sputum, and pus aspirates were collected and processed by standard microbiological methods. Antibiotic susceptibility testing (AST) was performed on Mueller-Hinton Agar using Kirby-Bauer disk diffusion method as per the current CLSI guidelines. Vancomycin susceptibility for Staphylococcus species was performed by Vancomycin Screen Agar test. Colistin susceptibility among Gram negative bacilli was done by Microbroth Dilution method for MIC determination.

Statistical analysis: Data were analysed using appropriate statistical tests. Categorical variables were compared using the Chi-square test and numerical variables using Student's t-test. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 150 patients were included in the study. Demographic and Clinical Characteristics of the included participants is summarized in table 1. Hypertension was the most frequent risk factor, present in 95 patients, followed by older age in 82, diabetes mellitus in 72, and anemia in 47 patients. Catheter-tip and peripheral blood samples were collected from all 150 patients. Culture positivity was highest in catheter-tip samples (46.7%), followed by sputum (46.2%), urine (45%), pus aspirate (40%), and peripheral blood (21.3%). Among the 150 patients, 38 had positive catheter-tip cultures with negative peripheral blood cultures categorized as Catheter Related Infection (CRI), whereas 32 showed concordant positivity in both catheter-tip and peripheral blood cultures and were categorized as catheter-related bloodstream infection (CRBSI). Both catheter-tip and peripheral blood cultures were negative in remaining patients. Distribution of bacterial isolates is shown in table 2.

Table 1: Demographic and Clinical Characteristics (n=150)

Variables		Frequency (%)	p-value
Age group	≤ 20 years	07 (4.7%)	<0.0001*
	21-30 years	28 (18.7%)	
	31-40 years	21 (14%)	
	41-50 years	12 (8%)	
	> 50 years	82 (54.6%)	

Gender distribution	Males	94 (62.7%)	0.0019*
	Females	56 (37.3%)	
Location wise	IPD	120 (80%)	<0.0001*
	OPD	30 (20%)	
Type of renal disease	CKD	119 (9.3%)	<0.0001*
	AKI	31 (20.7%)	
Duration of catheterization	Catheterization >14 days	95 (63.3%)	0.0011*
	Catheterization <14 days	55 (36.7%)	

Table 2: Distribution of Aerobic Bacterial Isolates from Various Samples

Isolates	Catheter tip (n=70)	Peripheral venous blood (n=32)	Urine (n=18)	Sputum (n=12)	Aspirate (n=6)
Staphylococcus aureus	23 (32.9%)	11 (34.4%)	1 (5.5%)	-	3 (50%)
Klebsiella species	10 (14.3%)	3 (9.4%)	3 (16.7%)	3 (25%)	1 (16.7%)
Escherichia coli	9 (12.8%)	2 (6.3%)	10 (55.6%)	2 (16.7%)	2 (33.3%)
Pseudomonas aeruginosa	13 (18.6%)	10 (31.2%)	2 (11.1%)	7 (58.3%)	-
Enterococcus species	15 (21.4%)	6 (18.7%)	2 (11.1%)	-	-

Among Staphylococcus aureus isolates, methicillin resistance was observed in 65.2% catheter-tip isolates, 72.7% peripheral blood isolates, and all isolates from urine and pus aspirate. All Staphylococcus aureus isolates were susceptible to linezolid, and none showed growth on vancomycin screen agar. All Enterococcal isolates were susceptible to vancomycin and linezolid, while urinary isolates showed 100% susceptibility to nitrofurantoin.

Among E. coli isolates, colistin and imipenem demonstrated the highest susceptibility across catheter-tip (100% and 77.8%), peripheral blood (100%), urine (100% and 70%), sputum (100%), and pus aspirate (100%) isolates. Urinary E. coli isolates showed 100% susceptibility to fosfomycin and colistin, while 80% to nitrofurantoin. Klebsiella species showed highest susceptibility to colistin and imipenem, with susceptibility rates of 100% and 70% in catheter-tip isolates respectively and 100% in peripheral blood, urine, sputum, and aspirate isolates. All urinary Klebsiella isolates were susceptible to colistin and nitrofurantoin. Among Pseudomonas aeruginosa, colistin and ceftazidime-avibactam showed the highest susceptibility, observed in 100% and 84.6% of catheter-tip isolates respectively and 100% of peripheral blood, urine, and sputum isolates.

DISCUSSION

This study highlights infections as a major complication in hemodialysis patients, particularly among those aged >50 years (54.6%), consistent with previous reports[8,9] attributing susceptibility to immunosenescence. Male predominance (62.7%) was observed, in line with earlier studies.[10] Chronic kidney disease was the underlying diagnosis in most patients (79.3%), and prolonged catheterization (>14 days) emerged as a significant risk factor.

Catheter-related infections were the leading cause of fever, with CRBSI documented in 21.3% and CRI in 25.3% of cases attributing various factors like biofilm formation, local inflammatory reaction, and thrombus formation which can progress to infectious complications.[11] Old age, diabetes, anemia, and prolonged hospitalization were significant risk factors, corroborating findings from prior studies.[12] Urinary tract infections accounted for 45% of febrile episodes, predominantly in elderly males, likely due to urinary stasis and comorbid conditions.

Gram-positive organisms, especially Staphylococcus aureus (32.9% catheter tip; 34.4% blood), were the predominant isolates, followed by Enterococcus species. Among Gram-negative bacteria, Pseudomonas aeruginosa was most frequent in catheter and respiratory samples, while Escherichia coli dominated urinary isolates (55.6%). These findings align with global literature reporting Gram-positive cocci as the leading pathogens in dialysis-related bacteremia.[13]

Antimicrobial resistance was notable, with high prevalence of MRSA (65–100%). However, Linezolid and Vancomycin retained universal efficacy against Gram-positive isolates. Enterobacterales showed high susceptibility to Colistin, Imipenem, Fosfomycin, and Nitrofurantoin. Pseudomonas aeruginosa was highly susceptible to Colistin, ceftazidime-avibactam, imipenem, gentamicin, and ciprofloxacin, underscoring their role in empirical therapy.

CONCLUSION

Fever in hemodialysis patients was predominantly due to catheter related infections, with Staphylococcus aureus being the leading pathogen and high MRSA prevalence indicates healthcare associated transmission, which limits empirical therapy to higher antibiotics, increasing morbidity, mortality, cost, and hospitalization. Overall, these outcomes emphasize the importance of regular microbiological surveillance, prudent antibiotic policies and targeted infection control practices for

early diagnosis of bacterial infections and to manage the threat of multidrug resistant infections in hemodialysis patients which will help to mitigate morbidity and mortality in hemodialysis patients.

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