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CATHETER RELATED BLOOD STREAM INFECTION IN PATIENTS ON HAEMODIALYSIS IN A TERTIARY HEALTHCARE CENTRE IN SOUTH INDIA: A RETROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Catheter-related bloodstream infections (CRBSIs) represent a critical concern in dialysis patients, particularly those reliant on central venous catheters for vascular access, and are a leading cause of morbidity and mortality. It is necessary for each hospital to conduct a microbiological profiling of CRBSI to identify the specific organisms in that patient population, determine the antibiotic resistance patterns and improve patient outcomes through tailored interventions.

Methods: We identified 45 patients with catheter-related blood stream infection. Clinical data was obtained through review of medical records. The data reported here are those available from October 2023 to March 2024. The objective of this study is to study the microbiological profile of dialysis patients with CRBSI in our tertiary care hospital.

Results: We identified 45 dialysis patients afflicted with catheter-related blood stream infection. 20 (44.44%) patients had probable CRBSI, 15 (33.33%) patients had possible CRBSI, 10 (22.22%) patients had definite CRBSI. 17 (37.7%) catheters were salvaged. Gram positive organisms were more frequently implicated, with methicillin resistant staphylococcus aureus being the most common organism grown in culture. Antibiograms were analysed in culture-positive probable and definite CRBSI.

Conclusion: CRBSI causal organisms found in our research population may differ from those found in other centres, thus highlighting the importance of each centre studying its microbiological spectrum and modifying empirical antibiotics accordingly. According to our study, the most common organism involved in CRBSI is MRSA. Analysis of antibiogram suggests using Vancomycin and Meropenem as empirical antibiotics, preferred over ceftazidime.

Categories: Internal Medicine, Nephrology

Keywords: Catheter related blood stream infection, CRBSI, hemodialysis, microbiological profile

INTRODUCTION:

Catheter-related bloodstream infections (CRBSIs) are defined as bloodstream infections that occur in the presence of an intravascular catheter, where the catheter is considered the source of the infection [1]. CRBSIs represent a critical concern in dialysis patients, particularly those reliant on central venous catheters for vascular access, and are a leading cause of morbidity and mortality. Given the high susceptibility of HD patients to infections due to frequent vascular access and immunocompromised status, it is necessary for each hospital to conduct a microbiological profiling of CRBSI to identify the specific organisms in that patient population, determine the antibiotic resistance patterns and improve patient outcomes through tailored interventions [2-4].

MATERIALS AND METHODS:

Study population, setting and data collection:
A retrospective observational study was performed in the Department of Internal Medicine in a tertiary care hospital in South India from October 2023 to March 2024. Inpatient records were screened for dialysis patients who developed CRBSI, and 45 patients satisfying the study definition of CRBSI were included in the study. Patients less than 18 years of age and pregnant women were excluded from the study.
This study has been approved by the Scientific Review Board of Saveetha Medical College and Hospital. Informed consent was waived, and researchers analysed only deidentified (anonymized) data. Records were obtained using the hospital's online database (Medical Information Archiving Software) and physical records, when required. We obtained demographic data, information on clinical symptoms or signs at presentation, and laboratory results during hospital admission. All laboratory tests and management were performed at the discretion of the treating physician.
Study definition:
The NKF-KDOQI (National Kidney Foundation Kidney Disease Outcomes Quality Initiative) criteria for Catheter-Related Bloodstream Infection (CRBSI) were updated in the 2019 KDOQI Clinical Practice Guideline for Vascular Access [5]. The criteria define probable CRBSI as follows:

- Probable CRBSI: Atleast one positive blood culture from a peripheral vein or dialysis circuit AND clinical signs of infection AND no other apparent source of infection.

Clinical signs of infection include fever, chills, hypotension, abnormal white blood cell count (leucocytosis or leucopenia).
Possible and definite CRBSI has not been defined explicitly in the NKF-KDOQI criteria and the frequently used clinical definition is taken as the study definition:

- Possible CRBSI: No laboratory evidence of blood stream infection, but symptoms subside after catheter removal (or) treatment with antibiotics.
- Definite CRBSI: Positive quantitative cultures from both catheter and peripheral blood, showing a high ratio of colony counts ($\geq$ 3:1) favouring the catheter as the source OR Positive cultures from the catheter segment with a clear time difference (at least 2 hours) compared to peripheral blood cultures.

Data collection:
The medical records of patients were retrospectively reviewed and evaluated for the above mentioned clinical and laboratory parameters. Patients were classified into probable, possible and definite CRBSI, as per NKF-KDOQI criteria.
Statistical analysis:
Statistical analysis was done using IBM SPSS Statistics software (version 29.0.2.0). Results are reported as means and percentages, as appropriate. No imputation was made for missing data. A p-value of <0.05 is taken as statistically significant.

RESULTS:

Demographic, laboratory and clinical characteristics of the patients:
A total of 45 patients were considered for the study. Age of the patients ranged between 26 to 81 years; mean ± SD was 45.2 ± 7.92 years. Host factors such as co-morbid conditions, laboratory parameters (including WBC count, platelet count, procalcitonin) and catheter type was noted. The demographic, laboratory and clinical characteristics of the patients have been elaborated in Table 1.
Type of CRBSI:
We identified 45 dialysis patients afflicted with catheter-related blood stream infection. According to NKF-KDOQI and criteria clinically accepted definitions of possible and definite CRBSI, patients were classified into probable, possible and definite CRBSI, which has been elaborated in Table 2.
Microbiological spectrum and antibiogram of organisms causing CRBSI:
Blood was taken from both dialysis catheter and peripheral blood and analysed for bacterial and fungal growth. 15 patients (who had possible CRBSI) did not yield any growth in their blood cultures. Out of the remaining 30 patients, only 1 patient showed fungal growth; Bacterial growth was noted in the remaining 29 patients.

17 patients showed gram-positive growth, 11 patients showed gram-negative growth. The microbial spectrum of organisms is illustrated in Figures 1 and 2, and the antibiograms and are listed in table 3 and 4.
1 patient showed probable CRBSI with fungal growth. Candida tropicalis was grown in the jugular venous catheter of the patient. The patient was treated with Caspofungin (as per culture sensitivity) and catheter was also removed.

Mortality:

3 patients (6.6%) succumbed to the illness during the study period, with the cause of death being septic shock with multi-organ dysfunction, secondary to CRBSI.

Statistical analysis:

Descriptives (n = 45):

- Culture-positive: 30/45 = 66.7% (95% CI 52.7–78.4).
- CRBSI categories: Probable 44.4% (95% CI 31.9–57.7), Possible 33.3% (95% CI 22.1–46.6), Definite 22.2% (95% CI 13.1–35.1).
- Catheter site: Jugular 84.4% (95% CI 71.8–91.9), Femoral 15.6% (95% CI 8.1–28.2).
- Catheter salvage: 37.8% (95% CI 25.7–51.7).
- Mortality: 6.7% (95% CI 2.3–17.6).

Microbiology:

- Bacterial isolates: 28

Gram-positive: 17 (60.7%, 95% CI 42.4–76.4)
Gram-negative: 11 (39.3%, 95% CI 23.6–57.6)

- Most common isolates: MRSA (n=9), Enterococcus (n=4), Klebsiella (n=4).

Empirical regimen coverage:

- Vancomycin covers 16/17 gram-positive isolates (all except the single MR-CONS).
- Meropenem covers 7/11 gram-negative isolates (Klebsiella, Enterobacter, Ralstonia).
- ***Vancomycin + Meropenem (combo)*** estimated coverage of bacterial isolates: 23/28 = 82.1% (95% CI 64.4–91.9).
  - *Note: Pseudomonas, Burkholderia, Acinetobacter, and Stenotrophomonas entries were Resistant to meropenem, according to our study.*

DISCUSSION

Catheter-related bloodstream infections (CRBSIs) remain one of the most serious complications associated with central venous catheters in hemodialysis patients, contributing substantially to morbidity and mortality. The high prevalence of CRBSI observed in our cohort highlights the vulnerability of patients reliant on catheters for vascular access. Prior studies have demonstrated that central venous catheters carry the greatest risk of bloodstream infection compared to other intravascular devices, consistent with our findings that infection rates were most pronounced among patients with jugular and femoral access [6,7].

MSSA (n=3)

Accurate diagnosis of CRBSI is often challenging due to overlapping features with other systemic infections. In our study, cases were classified as probable, possible, or definite based on NKF-KDOQI criteria and clinical definitions. This approach is consistent with the Infectious Diseases Society of America (IDSA) recommendations, which emphasize the utility of diagnostic tools such as differential time-to-positivity of blood cultures to confirm catheter-related infection [8,9]. However, in many resource-limited settings, such diagnostic modalities may not always be available, reinforcing the importance of integrating clinical judgment with culture results, as applied in our study.

The microbiological profile in our cohort was dominated by gram-positive organisms, particularly methicillin-resistant *Staphylococcus aureus* (MRSA). This finding mirrors global patterns where *S. aureus* remains the leading cause of CRBSI [10–12]. Importantly, MRSA infections are associated with higher morbidity, mortality, and lower catheter salvage rates compared with coagulase-negative staphylococci or less virulent organisms. Our antibiogram analysis indicated that vancomycin remains effective against MRSA in our population, supporting IDSA guidelines for the empirical use of vancomycin in suspected catheter-related *S. aureus* infections [10]. Recent systematic reviews suggest emerging alternatives such as daptomycin and ceftaroline in cases of persistent MRSA bacteremia, but vancomycin continues to be the most practical first-line therapy in many centers, including ours [11].

Gram-negative organisms, including *Klebsiella* and *Enterobacter* species, accounted for a significant proportion of isolates in our cohort. This echoes recent observations from sub-Saharan Africa and Asia, where multidrug-resistant gram-negative organisms are increasingly implicated in CRBSI [13]. In our series, meropenem demonstrated broad coverage against most gram-negative isolates, though resistance among *Pseudomonas* and non-fermenters was notable, underscoring the need for ongoing local surveillance to guide empirical therapy.

Catheter salvage was achieved in 37.7% of our patients, which is consistent with previously reported rates ranging from 20–50% [6,12]. Salvage was more successful in cases involving less virulent organisms and in patients without systemic instability, while MRSA and fungal infections typically required catheter removal. This aligns

with current recommendations advocating individualized decision-making based on pathogen type, clinical severity, and vascular access options [9].

The mortality rate in our study was 6.7%, which, although lower than some historical cohorts, highlights the persistent risk of death due to septic shock and multi-organ dysfunction in CRBSI patients [6,7]. This relatively lower rate may reflect early initiation of empirical therapy and ICU-based supportive care at our institution.

Taken together, our findings reinforce the importance of center-specific microbiological surveillance in shaping empirical antibiotic strategies. While vancomycin and meropenem provided the best empirical coverage in our population, emerging resistance patterns demand continual reevaluation of treatment protocols. Preventive strategies, including strict adherence to catheter care bundles, early conversion to arteriovenous fistulae when feasible, and antimicrobial lock therapies, remain crucial to reducing the burden of CRBSI [6,9,12].

Limitations:

The relatively small sample size and retrospective, single-center design restrict the generalizability of the findings. The lack of catheter-day data prevented calculation of incidence density rates, which would allow better comparisons with international cohorts. Furthermore, because only aggregate data were available, we were unable to explore independent predictors of salvage or mortality using multivariable analysis. Despite these limitations, our study contributes important microbiological and clinical data from a South Indian tertiary center, adding to the limited regional literature on CRBSI in dialysis patients.

Overall, the findings highlight MRSA as the predominant pathogen in our setting and support the empirical use of vancomycin and meropenem pending culture results. Regular microbiological surveillance and adherence to infection prevention bundles remain essential to reducing the burden of CRBSI and improving outcomes in hemodialysis patients.

CONCLUSION:

The study highlights the importance of understanding the microbiological profile and antibiotic resistance patterns in CRBSI among dialysis patients. Tailored empirical antibiotic therapy, based on local microbiological data, can improve patient outcomes. Further studies with a larger sample size are needed to validate these findings and develop institute-specific comprehensive guidelines for managing CRBSI in dialysis patients.

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Tables

Table 1: Demographic, Laboratory and clinical characteristics of the patients at baseline

FACTORS	FREQUENCY (PERCENTAGE) – n (%)
AGE	
• ≤60 years	36 (80%)
• >60 years	9 (20%)
GENDER	
• MALE	31 (68.8%)
• FEMALE	14 (31.1%)
CO-MORBIDITIES	
• Type 2 Diabetes Mellitus	37
• Systemic hypertension	32
• Ischemic Heart Disease	8
LABORATORY PARAMETERS	
• Leukocytosis (>11,000 cells/cu.mm)	29
• Leukopenia (<4,000/cu.mm)	7
• Thrombocytopenia (<1,00,000/cu.mm)	4
• Procalcitonin (>0.5 micrograms/litre)	36
CATHETER	
• Femoral	7
• Jugular	38

Table 2: Type of CRBSI

Type of CRBSI	Incidence – n(%)
• Probable CRBSI	20 (44.44%)
• Possible CRBSI	15 (33.33%)
• Definite CRBSI	10 (22.22%)

Table 3: Microbiological spectrum and antibiograms of gram-positive organisms

Note: MRSA – Methicillin resistant staphylococcus aureus, MR-CONS – Methicillin resistant coagulase-negative staphylococcus aureus, MSSA – Methicillin sensitive staphylococcus aureus, S – susceptible, R – resistant

Antibiotics	MRSA (n=9)	MR-CONS (n=1)	MSSA (n=3)	Enterococci (n=4)
Gentamicin	R	S	S	R
Ceftriaxone	R	R	R	R
Piperacillin+Tazobactam	R	R	S	R
Imipenem	R	S	S	R

Ertapenem	R	S	S	R
Meropenem	R	S	S	R
Ciprofloxacin	R	R	S	R
Clindamycin	S	R	R	S
Co-trimoxazole	S	S	R	R
Vancomycin	S	R	S	S
Linezolid	S	R	S	S
Teicoplanin	S	R	S	S

Table 4: Microbiological spectrum and antibiograms of gram-negative organisms
Note: S – susceptible, R – resistant

Antibiotics	Klebsiella (n=4)	Pseudo Monas (n=1)	Burkholderia (n=1)	Acineto Bacter (n=1)	Entero Bacter (n=2)	Ralstonia (n=1)	Steno Trophomonas (n=1)
Gentamicin	S	S	S	R	R	R	R
Ciprofloxacin	R	S	R	R	R	R	S
Imipenem	S	R	R	R	S	R	R
Meropenem	S	R	R	R	S	S	R
Colistin	S	R	R	S	R	R	R
Piperacillin/Tazobactam	S	S	R	R	R	S	R
Ceftazidime/Avibactam	S	S	S	R	R	R	S
Cefepime	S	S	R	R	S	S	R
Ceftriaxone	R	R	R	R	R	R	R

Figures:
Figure 1: Gram positive bacteria grown in culture

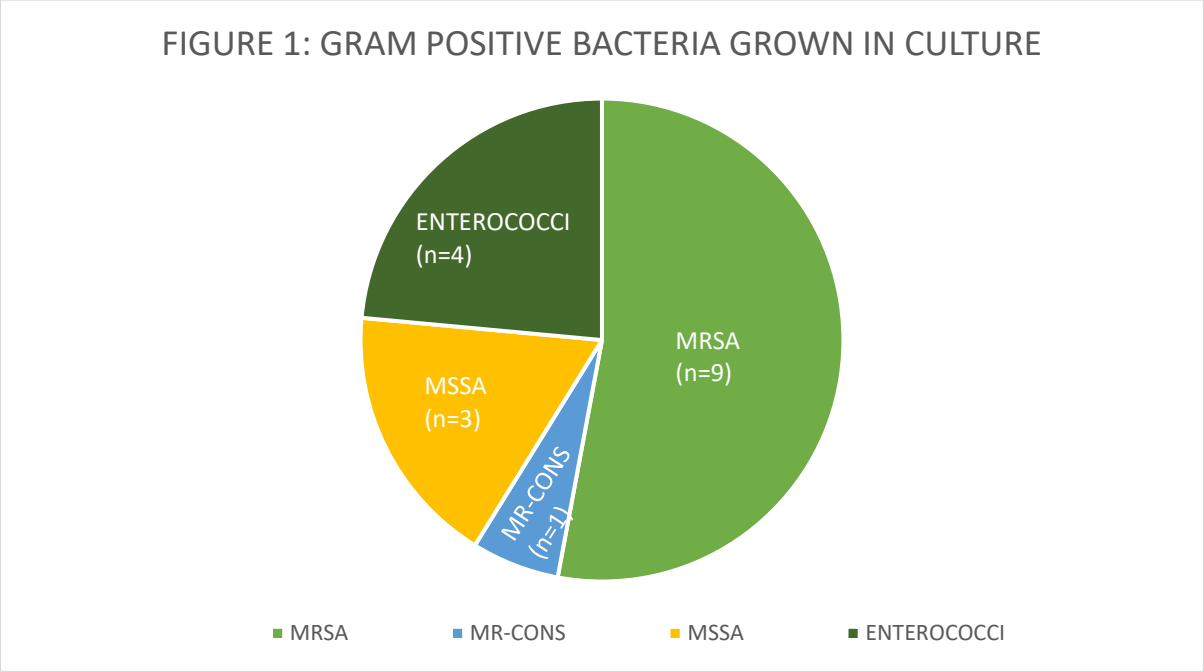

Figure 2: Gram negative bacteria grown in culture