RESEARCH PAPER

Clinical Profile and Outcomes of Culture-Negative Catheter-Related Bloodstream Infections in Hemodialysis Patients: A Cross-Sectional Study

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ABSTRACT

Introduction: Catheter-related bloodstream infections are important complications in haemodialysis patients using central venous catheters. A considerable proportion remain culture-negative despite clinical and laboratory evidence of infection.

Aim: To assess the clinical profile and outcomes of culture-negative catheter-related bloodstream infections among haemodialysis patients.

Materials and Methods: This hospital-based cross-sectional observational study was conducted over 18 months in the Department of General Medicine, Adichunchanagiri Hospital and Research Centre. Seventy-five adult haemodialysis patients with clinically suspected catheter-related bloodstream infection developing ≥48 hours after catheterisation and negative blood cultures were included. Demographic, comorbidity, catheter-related, laboratory, and outcome variables were recorded and analysed using SPSS version 26.

Results: Among 75 patients, males constituted 45 (60.0%). The 40–59 years and 60–79 years age groups included 26 patients (34.7%) each. Hypertension was present in 60 (80.0%) and diabetes mellitus in 31 (41.3%). Temporary catheters were used in 56 (74.7%), and jugular vein was the commonest insertion site in 53 (70.7%). Mean WBC count was 11887.52±2846.08 cells/mm³, CRP 56.04±18.72 mg/L, procalcitonin 3.94±1.36 ng/mL, and temperature 100.01±0.84°F. Sepsis and catheter removal occurred in 18 patients each (24.0%). Recovery was observed in 70 (93.3%), while mortality occurred in 5 (6.7%).

Conclusion: Culture-negative catheter-related bloodstream infection in haemodialysis patients represents a clinically significant entity, commonly associated with temporary jugular catheters and raised inflammatory markers, with notable risks of sepsis, catheter removal, and mortality.

Keywords: Renal Dialysis, Catheter-Related Infections, Bloodstream Infections, Central Venous Catheters, Cross-Sectional Studies.

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INTRODUCTION:

Catheter-related bloodstream infections (CRBSIs) are among the most frequent and serious complications in haemodialysis patients using central venous catheters.1,2 They contribute significantly to morbidity, prolonged hospital stays, increased healthcare costs, and risk of sepsis and death.1,3 The burden is higher in patients with temporary catheters, repeated catheter handling, and multiple comorbidities.4,5 Among suspected CRBSIs, a notable proportion are culture-negative, making them an important but less well-defined subgroup.6

Culture-negative CRBSI is increasingly recognized in clinical practice. It may occur due to prior empirical antibiotic use, low bacterial load, fastidious organisms, or technical limitations of routine culture methods.7-10 Despite negative blood cultures, patients often show clinical signs of infection such as fever and laboratory evidence of inflammation, including leukocytosis and raised CRP and procalcitonin.7,11 Important clinical outcomes include sepsis, catheter removal, and mortality, all of which influence management and prognosis.12

Most available studies on CRBSI focus mainly on culture-positive infections, microbiological isolates, and antibiotic resistance patterns. In contrast, the proportion, clinical profile, laboratory characteristics, and outcomes of culture-negative CRBSI remain inadequately described. Evidence from haemodialysis patients in tertiary care settings is particularly limited. Hence, our study was undertaken to determine the proportion of culture-negative CRBSI among suspected cases, describe the clinical and laboratory profile of affected haemodialysis patients, and assess outcomes such as sepsis, catheter removal, and mortality. This would help improve diagnosis, guide timely management, and support better antimicrobial stewardship.

MATERIALS & METHODS:

The present hospital-based cross-sectional observational study was conducted in the Department of General Medicine at Adichunchanagiri Hospital and Research Centre over a period of 18 months. The study included adult patients undergoing haemodialysis through central venous catheters who developed clinically suspected catheter-related bloodstream infection (CRBSI) during the study period.

A total of 75 patients aged 18 years and above were included. Patients of both sexes were enrolled. Eligible participants were those who had no clinical or microbiological evidence of bacteremia or sepsis at the time of catheter insertion, had received a central venous

catheter specifically for haemodialysis under strict aseptic precautions, and developed features suggestive of bloodstream infection 48 hours or more after catheterisation.

Patients below 18 years of age, those with central venous catheters inserted for indications other than haemodialysis, patients with bloodstream infection attributable to sources unrelated to catheter use, and those who had received systemic antibiotics after catheter insertion and before diagnosis of suspected CRBSI were excluded.

Culture-negative CRBSI was defined as clinically suspected catheter-related bloodstream infection in which no organism was isolated on appropriately collected blood cultures after excluding other possible sources of infection, based on WHO healthcare-associated infection surveillance principles and CDC-based diagnostic criteria.

Data were collected using a structured proforma. Demographic variables such as age and sex, comorbidities including diabetes mellitus and hypertension, catheter-related variables such as type of catheter, site of insertion, and duration of catheter placement, and laboratory parameters including total leukocyte count, C-reactive protein, procalcitonin, and temperature were recorded. Clinical outcomes such as development of sepsis, requirement for catheter removal, recovery, and mortality were documented.

Ethical Consideration

The study was conducted after obtaining approval from the Institutional Ethics Committee. The study procedures were in accordance with the ethical standards of the responsible institutional committee and the Helsinki Declaration of 1975, revised in 2013. Confidentiality of patient information was maintained throughout the study, and no patient names, initials, or identifying details were used.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) software, version 26.0. Continuous variables such as WBC count, CRP, procalcitonin, and temperature were expressed as mean and standard deviation. Categorical variables such as age group, sex, comorbidities, catheter type, catheter site, sepsis, catheter removal, recovery, and mortality were expressed as frequencies and percentages. Microsoft Excel and Microsoft Word were used for preparation of tables and graphical representation.

RESULTS:

A total of 75 haemodialysis patients with culture-negative catheter-related bloodstream infection were included in the study.

The majority of patients belonged to the 40–59 years and 60–79 years age groups, with males constituting the predominant gender. Hypertension was the most common comorbidity, followed by diabetes mellitus. The demographic profile and distribution of comorbidities are shown in Table/Fig 1-2.

Temporary catheters were used in most patients, and the jugular vein was the most common catheter insertion site. The distribution of catheter-related characteristics is summarized in Table/Fig 3.

Laboratory evaluation demonstrated elevated inflammatory markers among study participants. Mean WBC count, CRP, procalcitonin levels, and temperature indicated significant systemic inflammatory response suggestive of infection despite negative blood cultures. The laboratory profile is presented in Table/Fig 4.

With regard to clinical outcomes, the majority of patients recovered following treatment. However, a considerable proportion developed sepsis and required catheter removal. Mortality was observed in a small proportion of patients. The clinical outcomes are illustrated in Figure 2.

DISCUSSION:

The present study evaluated the clinical profile and outcomes of culture-negative catheter-related bloodstream infections (CRBSI) among haemodialysis patients. The findings demonstrate that culture-negative CRBSI represents a clinically significant clinical entity associated with elevated inflammatory markers, sepsis, catheter removal, and mortality despite negative blood cultures.

A predominance of middle- and older-aged patients was observed in the present study, with males constituting the majority of the study population. Similar male predominance has been reported by Bhojaraja et al.2, Opoku-Asare et al.12, Pegu et al.13, Costantine et al.14, and Phillips et al.15 In contrast, Fysaraki et al.16 reported a slight female predominance. The relatively younger age profile observed in the present study was comparable to that reported by Bhojaraja et al.2, Opoku-Asare et al.12, and Pegu et al.13, whereas Fysaraki et al.16, Costantine et al.14, and Phillips et al.15 described relatively older haemodialysis populations. These variations may be related to regional demographic characteristics, burden of chronic kidney disease, healthcare accessibility, and referral patterns.

Hypertension and diabetes mellitus were the major comorbidities identified in the present study. Similar findings have been documented by Bhojaraja et al.2, Fysaraki et al.16, Costantine et al.14, Phillips et al.15, Pegu et al.13, and Opoku-Asare et al.12 The high prevalence of hypertension observed in the present study highlights the close association between chronic kidney disease, vascular dysfunction, and long-term haemodialysis. Diabetes mellitus also remains an important contributor to end-stage renal disease and susceptibility to infection because of impaired immunity and vascular compromise.

The majority of patients in the present study had temporary haemodialysis catheters, while jugular vein was the most common insertion site. Comparable predominance of temporary or non-tunneled catheters has been reported by Bhojaraja et al.2, Costantine et al.14, and Pegu et al.13, whereas Phillips et al.15 reported predominance of tunneled catheters. Similarly, Fysaraki et al.16 observed comparatively fewer temporary catheters. With regard to catheter insertion site, the predominance of jugular access in the present study was similar to the observations of Bhojaraja et al.2, Opoku-Asare et al.12, and Costantine et al.14 Temporary catheters are recognised to carry increased risk of infection because of repeated manipulation, lack of subcutaneous tunnelling, and use in urgent dialysis settings.

An important finding of the present study was the presence of elevated inflammatory markers despite negative blood cultures. Raised WBC count, CRP, procalcitonin, and fever strongly supported the presence of genuine infective pathology. Similar observations regarding leukocytosis and inflammatory response in CRBSI have been reported by Bhojaraja et al.2 and Fysaraki et al.16 The role of procalcitonin as a useful biomarker in haemodialysis-related bloodstream infections has also been highlighted by Imam et al.11 Furthermore, the observations of Opota et al.8, Cheng et al.9, and Lamy et al.10 support the possibility of culture negativity due to low bacterial load, prior antimicrobial exposure, fastidious organisms, or limitations in routine blood culture techniques.

The present study also demonstrated that culture-negative CRBSI constituted a clinically important subset of suspected infections. This observation supports the concepts discussed in the Infectious Diseases Society of America guidelines by Mermel et

al.6 and the review by Baang et al.7, which emphasise that absence of microbiological isolation does not exclude catheter-related infection in the presence of strong clinical and laboratory evidence. Therefore, culture-negative CRBSI should not be considered a benign or non-infective condition.

Sepsis and catheter removal occurred in a considerable proportion of patients in the present study, indicating significant morbidity associated with culture-negative CRBSI. Similar complications have been documented by Bhojaraja et al.2, Pegu et al.13, Fysaraki et al.16, and Phillips et al.15 Mortality in the present study was relatively lower than that reported in several earlier studies, including those by Pegu et al.13, Fysaraki et al.16, and Phillips et al.15, but was comparable to the findings of Bhojaraja et al.2 These differences may reflect variations in early recognition, empirical antimicrobial therapy, catheter management practices, severity of illness, and institutional infection-control measures.

The present study has certain limitations. It was a single-centre study with a relatively small sample size. Advanced microbiological and molecular diagnostic techniques were not available, which may have improved pathogen detection in culture-negative cases. In addition, the absence of a culture-positive comparison group limited comparative analysis of outcomes and risk factors.

Nevertheless, the study highlights the clinical importance of recognising culture-negative CRBSI among haemodialysis patients. Elevated inflammatory markers, fever, and significant clinical outcomes despite negative blood cultures emphasise the need for careful clinical evaluation and timely management. Further multicentric studies with larger sample sizes and advanced microbiological diagnostic techniques are recommended to better define the epidemiology, microbial spectrum, and optimal management strategies for culture-negative CRBSI.

CONCLUSION:

Our study showed that culture-negative catheter-related bloodstream infection in haemodialysis patients was more common among middle- and older-aged males, with hypertension and diabetes as frequent comorbidities. Most patients had temporary catheters, predominantly placed in the jugular vein. Despite negative blood cultures, patients demonstrated clear clinical and laboratory evidence of infection, including fever, leukocytosis, raised CRP, and elevated procalcitonin. Nearly one-fourth developed sepsis and required catheter removal, while mortality was observed in a small proportion. Overall, our study justifies its objectives by demonstrating that culture-negative CRBSI represents a clinically significant entity requiring prompt recognition and timely management.

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DECLARATIONS

Declaration of Conflict of Interest

The authors declare that they have no conflicts of interest to disclose.

Declaration of Previous Publication/Submission

The authors declare that this manuscript has not been published previously in any language and is not under consideration for publication elsewhere. No part of this work has been published or submitted elsewhere.

Protection of Patients' Rights to Privacy

Patient confidentiality was maintained throughout the study. No names, initials, hospital registration numbers, photographs, imaging records, pedigrees, or any other identifying information of patients have been included in the manuscript. As no identifiable patient information is presented, separate written consent for publication was not applicable.

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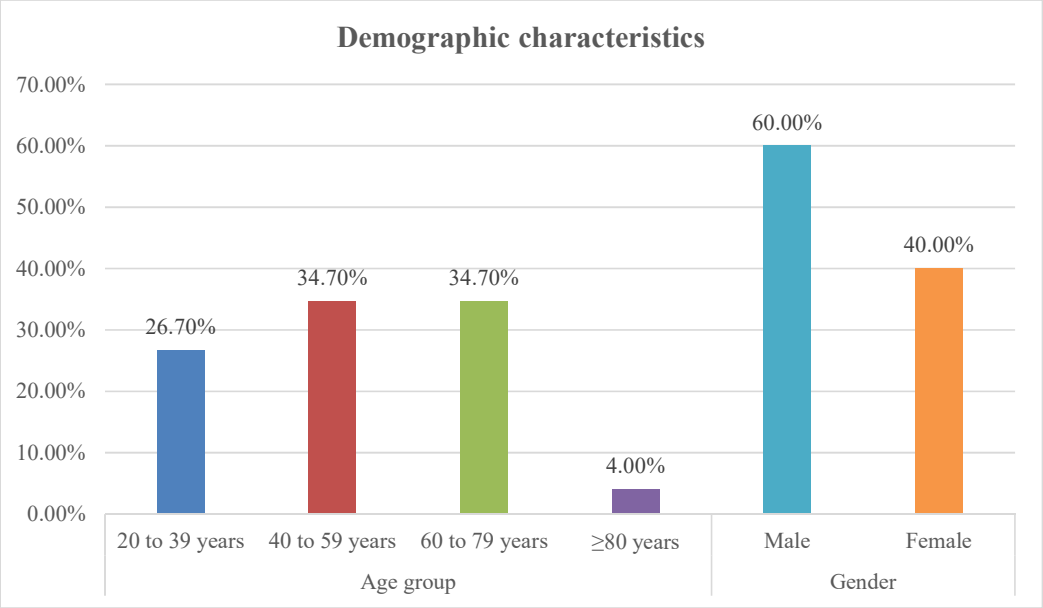
TABLES & FIGURES



Table/Fig 1: Demographic characteristics of study participants

Comorbidities		Frequency (N)	Percentage (%)
Diabetes	Yes	31	41.3%
	No	44	58.7%
Hypertension	Yes	60	80.0%
	No	15	20.0%

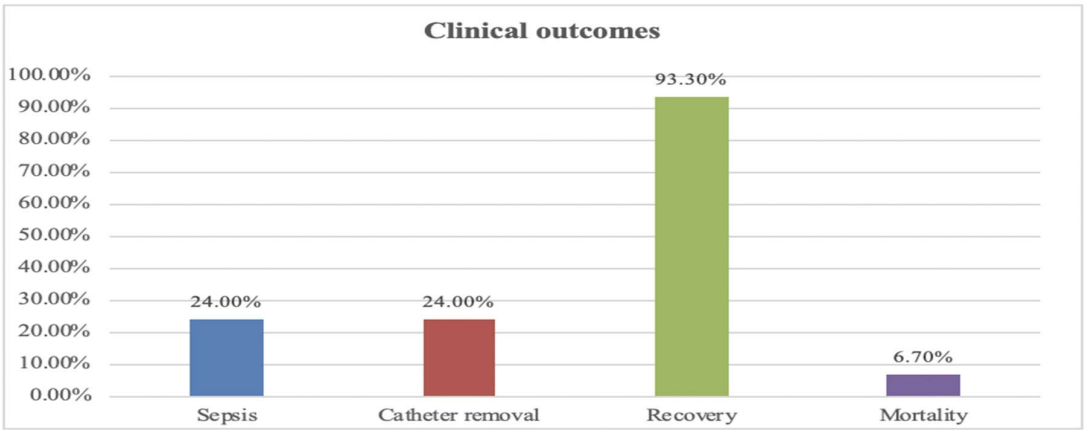
Table/Fig 2: Distribution of comorbidities among study participants:

Comorbidities		Frequency (N)	Percentage (%)
Catheter type	Temporary	56	74.7%
	Tunneled	19	25.3%
Site	Jugular	53	70.7%
	Femoral	19	25.3%
	Subclavian	3	4.0%
Duration		8 to 14 days	

Table/Fig 3: Distribution of catheter characteristics among study participants

Parameter	Mean	SD
WBC count (cells/mm³)	11887.52	2846.08
CRP (mg/L)	56.04	18.72
Procalcitonin (ng/mL)	3.94	1.36
Temperature (°F)	100.01	0.84

Table/Fig 4: Laboratory profile of culture-negative group
WBC: White blood cell; CRP: C-reactive protein; SD: Standard deviation



Table/Fig 5: Clinical outcomes among study participants

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Declaration of Previous Publication/Submission
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Protection of Patients' Rights to Privacy
Patient confidentiality was maintained throughout the study. No names, initials, hospital registration numbers, photographs, imaging records, pedigrees, or any other identifying information of patients have been included in the manuscript. As no identifiable patient information is presented, separate written consent for publication was not applicable.