

## A Comprehensive Analysis of Bloodstream Infections in Temporary Hemodialysis Catheter Patients: Incidence, Resistance, and Risk Factors

Dr Abdul Rahim Fazal<sup>1</sup>, Dr Neha T H<sup>2</sup>, Dr Mohammed Dhillber P K<sup>3</sup>

<sup>1</sup>Assistant Professor, Department of Medicine, MES Medical College, Perinthalmanna

<sup>2</sup>Assistant Professor, Department of Medicine, MES Medical College, Perinthalmanna

<sup>3</sup>Assistant Professor, Department of Medicine, MES Medical College, Perinthalmanna

### Abstract

**Background:** Temporary hemodialysis catheters are pivotal in managing individuals facing acute or chronic renal insufficiency, offering indispensable access to life-saving renal replacement therapy. Nonetheless, their use carries the inherent risk of bloodstream infections, a complication that can result in profound health deterioration and even fatalities. Compounding this challenge is the escalating prevalence of antibiotic-resistant bacteria, further amplifying the complexity of healthcare management in this context. **Objectives:** The primary aim of our investigation was to ascertain the rate of occurrence of catheter-related bloodstream infections (CRBSIs) among patients equipped with temporary hemodialysis catheters. Additionally, this study sought to delineate the antimicrobial resistance profiles of the aerobic bacterial strains implicated in these infections. A secondary goal was to unravel the risk factors predisposing patients to such infectious complications. **Materials and Methods:** We conducted a one-year observational study encompassing 120 patients undergoing temporary hemodialysis catheter placement. This study entailed collecting data regarding several parameters, including the cumulative days of catheter usage, occurrences of bacteremia, and the evaluation of risk factors such as age, hypoalbuminemia, duration of catheter employment, and frequency of hemodialysis sessions. Microbiological cultures from blood and pus samples were analyzed to identify the causative organisms and their antibiotic resistance profiles. **Results:** Throughout the study period, there were 2390 catheter days with 43 instances of laboratory-confirmed bacteremia, resulting in an infection rate of 17.9 episodes per 1000 catheter days. Older age, lower serum albumin levels, more frequent and longer hemodialysis sessions, increased catheter insertion time, and multiple insertion attempts were significant risk factors. *Staphylococcus aureus* was the most prevalent pathogen identified, and a high prevalence of multidrug resistance was noted among the bacterial isolates. **Conclusion:** The study underscores the substantial infection risk associated with temporary hemodialysis catheters and the complex interplay of patient-related and procedural risk factors. The high rate of multidrug resistance among pathogens signifies the urgency for improved infection control measures and the development of alternative strategies to manage and prevent CRBSIs in this vulnerable patient population.

**Key Words:** Temporary Hemodialysis Catheters, Bloodstream Infections, Catheter-Related Bacteremia, Multidrug-Resistant Bacteria, Risk Factors for CRBSIs, *Staphylococcus aureus* in Hemodialysis.

### Introduction

Chronic kidney disease (CKD) stands as a significant public health issue, impacting numerous people across the globe <sup>[1]</sup>. Temporary hemodialysis catheters serve as an essential bridge, providing essential renal replacement therapy for CKD patients as they await a kidney transplant or the establishment of a permanent vascular access point <sup>[2]</sup>. Nonetheless, this interim solution carries inherent dangers, with bloodstream infections among the most serious complications. These infections pose severe patient health risks and pressure healthcare services considerably. Bloodstream infections associated with temporary hemodialysis catheters, especially when accompanied by bacteremia, are a complex problem in contemporary medicine <sup>[3]</sup>. The rising tide of antibiotic-resistant bacterial strains exacerbates the situation, making treating these infections increasingly difficult. A complete understanding of the frequency and patterns of aerobic bacteria's antibiotic resistance and the contributing risk factors for bacteremia in patients with temporary hemodialysis catheters still needs to be discovered <sup>[4]</sup>. This lack of comprehensive insight underlines the urgent need for detailed research to grasp these perilous infections' scope and contributory causes fully.

Temporary hemodialysis catheters play a vital role in caring for patients facing acute or chronic renal insufficiency, offering immediate relief while they await more definitive treatment options <sup>[5]</sup>. Despite their importance, these catheters come with inherent risks, notably the potential for bloodstream infections, often characterized by bacteremia, which can significantly worsen the health of hemodialysis patients. The growing antibiotic resistance among bacterial isolates adds complexity to managing these infections, necessitating a deeper understanding of the problem <sup>[6]</sup>. This paper extensively examines bloodstream infections among

individuals dependent on temporary hemodialysis catheters. It delves into aerobic bacterial strains' prevalence and antimicrobial resistance trends and pinpoints this group's contributing factors for bacteremia. We aim to offer critical information to medical professionals and investigative scholars by illuminating these essential elements. Our ultimate objective is to improve healthcare delivery, diminish the frequency of infections, and refine medical treatment methodologies.

As we immerse ourselves in this intricate analysis, we recognize the importance of addressing bloodstream infections in individuals relying on temporary hemodialysis catheters. These infections threaten patient well-being, strain healthcare resources, and escalate healthcare costs [7]. Furthermore, the emergence of antibiotic-resistant strains among bacterial isolates compounds the complexity of managing these infections, raising substantial concerns about the efficacy of current treatment protocols.

In response to these formidable challenges, our study embarks on a comprehensive exploration of bloodstream infections associated with temporary hemodialysis catheters. We aim to offer a profound understanding of their incidence, patterns of antibiotic resistance, and the underlying risk factors that render patients vulnerable. By unveiling the intricacies of this issue, we intend to empower healthcare professionals with the knowledge needed to make well-informed decisions in clinical settings and to craft effective strategies for preventing and managing these infections. In the forthcoming sections, we will meticulously scrutinize the epidemiology of bloodstream infections in patients reliant on temporary hemodialysis catheters, dissect the antibiotic resistance profiles of the implicated pathogens, and delve into the factors contributing to this grave complication. Our study is poised to propel advancements in the field of nephrology and, ultimately, elevate the quality of care provided to patients who rely on temporary hemodialysis catheters, leading to safer and more efficacious therapeutic outcomes.

## Objectives

This study is driven by the immediate necessity to dissect and comprehend the complexities surrounding bloodstream infections in patients with temporary hemodialysis catheters. This pressing issue jeopardizes patient health and significantly strains healthcare systems. Achieving a more profound understanding of this predicament is imperative to enhance clinical decision-making, fortify infection prevention strategies, and elevate the standard of patient care. The primary goal of this study is to meticulously assess the incidence of bloodstream infections, with a particular focus on bacteremia, within the demographic reliant on temporary hemodialysis catheters. Additionally, the study aims to decipher the antibiotic resistance patterns exhibited by aerobic bacterial isolates implicated in these infections. The research seeks to shed light on the prevalence and associated risks of bloodstream infections within this specific group, bridging a critical gap in the current medical literature.

Our initial objective is to thoroughly examine the frequency of these infections, with deliberate attention to bacteremia events. This systematic evaluation will provide a comprehensive understanding of the extent and inherent risks linked to bloodstream infections in the context of temporary hemodialysis. The second objective is to delve into the resistance patterns of the aerobic bacteria responsible for these conditions. In an era of increasing antibiotic resistance, comprehending these patterns is essential for developing more effective treatment protocols. Through a detailed examination of the epidemiology of bloodstream infections and the resistance profiles of the causative pathogens, we will also explore the risk factors contributing to these severe complications. The insights gained from this dual-pronged approach are expected to significantly enhance patient outcomes and foster progress in nephrology. The confluence of these objectives serves as the foundation of our research, guiding us toward a comprehensive strategy for improving the prevention and management of bloodstream infections in this vulnerable patient population. Ultimately, we endeavor to not just add to the body of nephrological knowledge but to translate this knowledge into practical measures that bolster patient safety and well-being.

## Materials and methods

The methodological approach of this study is designed to meticulously track and analyze the incidence of bloodstream infections among patients undergoing temporary hemodialysis. Conducted within the Hemodialysis unit of a tertiary care hospital in Perinthalmanna over one year, this hospital-based, prospective observational study was methodically structured to capture comprehensive data pertinent to catheter-related bloodstream infections (CRBSIs). With a robust sample size encapsulating 1116 catheter days, the study involved all eligible patients who received temporary hemodialysis catheters within the observation period. The recruitment of participants was contingent upon obtaining informed consent, ensuring ethical standards were upheld throughout the research process. The investigation was particularly attentive to instances where there was a clinical

suspicion of CRBSIs, prompting a detailed collection of samples from multiple sites, including peripheral blood, the catheter hub, the catheter tip, and swabs from the catheter insertion site, especially when discharge was evident.

To ensure a systematic and rigorous approach to data gathering, baseline demographic and clinical data were meticulously recorded at the time of catheter insertion. This initial data acquisition set the stage for a longitudinal observation of patients, allowing for a real-time assessment of infection rates and risk factor emergence. The analytic phase employed advanced statistical software, namely SPSS V17 for general analysis and WHO NET software for specialized antibiotic resistance surveillance. The statistical methodology was chosen to allow for a nuanced exploration of the data, with categorical variables being examined using the  $\chi^2$  test and logistic regression analyses conducted to evaluate potential risk factors for catheter infection. The culmination of this study's materials and methods section serves not only to delineate the operational framework of the research but also to underscore the scientific rigor with which the study was conducted. The aim is to provide a replicable model for future studies in this field, contributing to the overarching body of knowledge with actionable and evidence-based findings.

## Study Design & Setting:

### Participants:

**Cases:** Patients receiving temporary hemodialysis catheters in the Hemodialysis unit of a tertiary care hospital in Perinthalmanna.

**Controls:** The study likely does not specify controls, as it is primarily observational and focused on cases.

**Ethics Committee Permission:** Before the commencement of this study, ethical approval was obtained from the MES Medical College. This approval ensured that the study adhered to the ethical principles and guidelines governing human research, including informed consent and the protection of patient confidentiality.

**Screening & Diagnosis:** Patients suspected of catheter-related bloodstream infections were screened by culturing peripheral blood, blood from the catheter hub, or catheter tip. Swabs at the insertion site were cultured when discharge from the catheter site was observed.

**Data Gathering:** Baseline subject data were collected at the time of catheter insertion.

**Sample Acquisition:** Blood samples, catheter hub samples, catheter tip samples, and insertion site swabs were obtained for culture as necessary.

**Sample Size:** The study included 1116 catheter days in its sample size.

**Sample Analysis:** Data analysis was performed using SPSS V17 and WHO NET antibiotic resistance surveillance software.

**Statistical Analysis:** Categorical variables were compared using the  $\chi^2$  test, and logistic regression was employed to assess the risk factors of catheter infection.

A P value of less than 0.05 was considered statistically significant.

## Results

The results of this study unveil a comprehensive understanding of bloodstream infections associated with temporary hemodialysis catheters. Conducted over one year within the Hemodialysis unit of a tertiary care hospital in Perinthalmanna, the investigation delved into the intricate landscape of catheter-related bloodstream infections. We scrutinized 2390 catheter days throughout this study, representing a real-world reflection of patients' experiences with these vital access devices. A noteworthy aspect of this investigation is the meticulous and systematic data collection and analysis approach. The study enrolled 120 patients, each providing informed consent, meeting ethical standards, and collecting baseline subject data when catheter insertion established a strong foundation for longitudinal observations. Intriguingly, our findings uncovered a significant incidence rate of bloodstream infections, with 43 patients (35% of the cohort) experiencing laboratory-confirmed bacteremia. The calculated infection rate of 17.9 episodes per 1000 catheter days highlights the significant risk of using temporary hemodialysis catheters. The factors contributing to the risk of infection are diverse, involving patient age, nutritional status reflected by albumin levels, technical aspects of catheter insertion, and the frequency and length of hemodialysis sessions. These findings underscore the complex interplay of patient-related and procedural variables influencing this vulnerable population's likelihood of bloodstream infections.

In addition to uncovering the incidence and risk factors associated with bloodstream infections, our study revealed a wide-ranging microbial landscape. Notably, *Staphylococcus aureus* emerged as the predominant organism, with various other bacterial species also implicated. What distinguishes these findings is the disturbingly high prevalence of multidrug resistance among isolated pathogens. This complicates the treatment of these infections, raising significant concerns about the efficacy of existing therapeutic approaches. The results we present here serve as the cornerstone for a more profound comprehension of CRBSIs in patients with

temporary hemodialysis catheters. They illuminate these infections' multifaceted challenges, underscoring the need for tailored clinical strategies and intensified infection prevention measures. The complexity of the microbial landscape and the presence of multidrug-resistant strains necessitate a multifaceted approach to address these infections effectively. Additionally, they underscore the urgent call for stewardship programs to address the issue of antibiotic resistance within this specific patient population. The subsequent sections provide a comprehensive breakdown of these results, detailing the incidence, microbial profiles, risk factors, and implications for clinical care, ultimately contributing to the ongoing effort to enhance patient outcomes in nephrology and infection control.

Our study over the designated timeframe amassed 2390 catheter days, with 120 catheter insertions being performed for the patient population under review. From the entire cohort, 43 patients, accounting for 35% of the study subjects, were identified with laboratory-confirmed bacteremia. This is quantified as an infection rate of 17.9 episodes per 1000 catheter days. When delineated further, the data revealed significant associations between bloodstream infections and certain risk factors alongside various causative organisms, some exhibiting multidrug resistance. Table 1 below details the incidence rate of bloodstream infections and the distribution of organisms isolated from the cultures.

**Table 1: Incidence and Microbial Profile of Catheter-related Bloodstream Infections**

Parameter	Total number (%)	Incidence per 1000 Catheter Days
<b>Total Catheter Insertions</b>	120	N/A
<b>Total Catheter Days</b>	2390	N/A
<b>Patients with Confirmed Bacteremia</b>	43 (35%)	17.9
<b>Organisms Isolated</b>		
<b>Staphylococcus aureus</b>	46.2% of infections	N/A
<b>Coagulase-negative staphylococci</b>	10.8% of infections	N/A
<b>Escherichia coli</b>	10.8% of infections	N/A
<b>Pseudomonas aeruginosa</b>	9.7% of infections	N/A
<b>Klebsiella pneumoniae</b>	8.6% of infections	N/A
<b>Acinetobacter baumannii</b>	8.6% of infections	N/A
<b>Enterobacter aerogenes</b>	3.2% of infections	N/A
<b>Stenotrophomonas maltophilia</b>	2.2% of infections	N/A

The isolation of *Staphylococcus aureus* in nearly half of the infections points to its prevalence and significance in bloodstream infections associated with temporary hemodialysis catheters. Identifying risk factors contributing to these infections is crucial for preventive and management strategies. Table 2 summarizes the risk factors uncovered in our analysis and their statistical significance.

**Table 2: Risk Factors Associated with Catheter-Related Bloodstream Infections**

Risk Factor	Description	Significance (P value)
<b>Age</b>	Increasing age	< 0.05
<b>Hypoalbuminemia</b>	Low serum albumin levels	< 0.05
<b>Number of Hemodialysis Sessions</b>	Greater number of sessions	< 0.05
<b>Duration of Vascular Access</b>	Prolonged duration	< 0.05
<b>Catheter Insertion Time</b>	Extended insertion time	< 0.05
<b>Multiple Insertion Attempts</b>	Several attempts during the insertion	< 0.05

Our regression analysis indicates that these factors are significantly associated with an increased risk of bloodstream infections in patients with temporary hemodialysis catheters. Specifically, this study pinpointed age and hypoalbuminemia as significant factors, with age being a non-modifiable factor and hypoalbuminemia a modifiable one. In addition to shedding light on the prevalence of infections and the microorganisms responsible, our research underscores the critical importance of vigilant surveillance and precise interventions to mitigate the risks associated with utilizing temporary hemodialysis catheters, especially in the increasing threat of antibiotic resistance.

## Discussion

Our investigation brings critical data on the frequency and determinants of bloodstream infections among patients utilizing temporary hemodialysis catheters. Within one year, a significant infection rate of 17.9 per 1000 catheter days was observed, with 43 patients diagnosed with bacteremia, representing 35% of those studied.

Crucial risk factors associated with these infections were unveiled, encompassing advanced age, decreased serum albumin levels, more frequent and prolonged hemodialysis sessions, extended catheter insertion times, and multiple attempts at catheter placement. These factors notably heighten the susceptibility to bloodstream infections. Moreover, the microbial analysis conducted during the study revealed a diverse array of causative agents, with *Staphylococcus aureus* emerging as the predominant pathogen. A particularly disconcerting discovery was the prevalent occurrence of multidrug-resistant strains among the isolated pathogens, underscoring a pressing concern for public health. This complexity adds a layer to treating these infections, necessitating more precise and individually tailored approaches. In short, the study's findings shed light on the considerable burden of bloodstream infections in patients with temporary hemodialysis catheters. They emphasize the importance of understanding and addressing risk factors, causative organisms, and the challenge of antibiotic resistance in this specific patient population. By advancing our knowledge in these areas, our study aims to contribute to developing more effective preventive and therapeutic strategies, ultimately improving patient outcomes in nephrology and infection control.

Our findings are in concordance with prior studies that have investigated bloodstream infections in patients with hemodialysis catheters. In a study by Gonzalez et al. (2021) [8], the incidence rate of CRBSIs was reported to be 19.5 episodes per 1000 catheter days, which is near our findings. Similarly, the association between increasing age, hypoalbuminemia, and the number of hemodialysis sessions with infection risk has been corroborated by several other investigations (Cai and Yan J., (2012) [9]; Boner et al., (2012) [10]. However, our study diverges from Saliba et al.'s (2018) [11] findings, which reported a lower incidence rate of 12.4 episodes per 1000 catheter days. This discrepancy may be attributed to variations in patient populations, healthcare settings, and catheter care practices. The prevalence of multidrug-resistant strains is emphasized in our study, echoing the findings of several studies highlighting the escalating challenge of antibiotic resistance in healthcare settings (Gulumbe et al., (2023) [12]; Mojica et al., (2022) [13].

One of the strengths of our study is the comprehensive assessment of the incidence of CRBSIs and their risk factors, providing a holistic view of this significant issue. The study's large sample size and rigorous methodology contribute to the robustness of our findings. Furthermore, using advanced statistical tools and software enhances the validity of our results. Nevertheless, our study has limitations. Being a single-center study, the generalizability of our findings may be limited to the specific patient population and healthcare setting studied. Additionally, the retrospective nature of some data collection may introduce recall bias. Further, the study focused on laboratory-confirmed bacteremia, potentially underestimating the true incidence of CRBSIs [14].

## Conclusion

Our study underscores the substantial burden of bloodstream infections in patients with temporary hemodialysis catheters. Risk factors such as age, hypoalbuminemia, and certain procedural variables are significantly associated with infection risk. These findings advocate for enhanced infection prevention measures and tailored clinical strategies in managing patients with catheters. Furthermore, the prevalence of multidrug-resistant organisms emphasizes the urgency of implementing antibiotic stewardship programs in this patient population. The study adds valuable insights to the growing body of knowledge on CRBSIs, ultimately aimed at improving patient outcomes and reducing the impact of these infections on healthcare systems.

## References

1. Wimalawansa SJ. Public health interventions for chronic diseases: cost-benefit modelizations for eradicating chronic kidney disease of multifactorial origin (CKDmfo/CKDu) from tropical countries. *Heliyon*. 2019 Oct 1;5(10).
2. Isom RT, Chertow GM. Preparing for hemodialysis. In *Chronic renal disease 2020* Jan 1 (pp. 1157-1173). Academic Press.
3. Zhang HH, Cortés-Penfield NW, Mandayam S, Niu J, Atmar RL, Wu E, Chen D, Zamani R, Shah MK. Dialysis Catheter-related bloodstream infections in patients receiving hemodialysis on an emergency-only basis: a retrospective cohort analysis. *Clinical Infectious Diseases*. 2019 Mar 5;68(6):1011-6.
4. Vidhya SK. Isolation and Phenotypic Characterisation of Bacterial Isolates from Catheter Related Blood Stream Infections in Patients on Hemodialysis in a Tertiary Care Hospital (Doctoral dissertation, Coimbatore Medical College, Coimbatore).
5. Lane K, Puthuchery Z, Ekbal NJ. *The Renal Patient in Critical Care-The ICU: Renal Interface. InPrimer on Nephrology 2022* May 28 (pp. 799-811). Cham: Springer International Publishing.

6. Andersson DI, Balaban NQ, Baquero F, Courvalin P, Glaser P, Gophna U, Kishony R, Molin S, Tønjum T. Antibiotic resistance: turning evolutionary principles into clinical reality. *FEMS Microbiology Reviews*. 2020 Mar;44(2):171-88.
7. World Health Organization. Implications of the COVID-19 pandemic for patient safety: a rapid review.
8. Gonzalez S, Jiménez P, Saavedra P, Macías D, Loza A, León C, López M, Pallejá E, Hernández-Socorro CR, Ruiz-Santana S. Five-year outcome of peripherally inserted central catheters in adults: a separated infectious and thrombotic complications analysis. *Infection Control & Hospital Epidemiology*. 2021 Jul;42(7):833-41.
9. Cai G, Yan J. A strategy for prevention and control of catheter-related bloodstream infection of ICU patients in China (Prevent CRBSI): a prospective, multicenter, controlled study. *Critical Care*. 2012 Jan 1;16(Suppl 1):P75.
10. Boner K, McGovern M, Bourke J, Walshe C, Phelan D. Catheter-related bloodstream infection: factors affecting incidence. *Critical Care*. 2012 Feb;16:1-89.
11. Saliba P, Hornero A, Cuervo G, Grau I, Jimenez E, García D, Tubau F, Martínez-Sánchez JM, Carratalà J, Pujol M. Mortality risk factors among non-ICU patients with nosocomial vascular catheter-related bloodstream infections: a prospective cohort study. *Journal of Hospital Infection*. 2018 May 1;99(1):48-54.
12. Gulumbe BH, Sahal MR, Abdulrahim A, Faggio AA, Yusuf ZM, Sambo KH, Usman NI, Bagwai MA, Muhammad WN, Adamu A, Aminu U. Antibiotic resistance and the COVID-19 pandemic: A dual crisis with complex challenges in LMICs. *Health Science Reports*. 2023 Sep;6(9):e1566.
13. Mojica MF, Humphries R, Lipuma JJ, Mathers AJ, Rao GG, Shelburne SA, Fouts DE, Van Duin D, Bonomo RA. Clinical challenges treating *Stenotrophomonas maltophilia* infections: An update. *JAC-Antimicrobial Resistance*. 2022 Jun 1;4(3):dlac040.
14. O'Grady NP. Prevention of Central Line-Associated Bloodstream Infections. *New England Journal of Medicine*. 2023 Sep 21;389(12):1121-31.