

**CLINICAL PROFILE AND OUTCOMES OF CULTURE-POSITIVE
CATHETER-RELATED BLOODSTREAM INFECTION WITH AND WITHOUT
ANTIBIOTIC LOCK THERAPY IN HEMODIALYSIS PATIENTS****Dr. K. Sree Harsha Vardhan*, Dr. Manjusha Yadla, Dr. P. Srinivas**

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ABSTRACT

Background: Catheter-related bloodstream infection (CRBSI) is an important complication of central venous catheter use in patients receiving hemodialysis. Antibiotic lock therapy is intended to reduce intraluminal microbial persistence and may improve catheter salvage and longevity. **Objective:** To describe the clinical profile and outcomes of culture-positive CRBSI patients managed with and without antibiotic lock therapy. **Methods:** This retrospective observational study included 158 patients with culture-positive CRBSI admitted to Gandhi Hospital between January 2024 and December 2025. Patients had tunneled or non-tunneled catheters. Gentamicin lock therapy, when used, was administered after each hemodialysis session using gentamicin sulfate diluted with 0.9% sodium chloride, with the lock volume corresponding to the internal catheter-lumen volume. **Results:** The mean age was 54.96 ± 8.90 years and 67.7% of patients were male. Non-tunneled catheters accounted for 55.7% and tunneled catheters for 44.3%. *Staphylococcus aureus* was the most frequent isolate (29.1%), followed by coagulase-negative staphylococci (24.1%). In the comparison presented in the source dataset, time to first CRBSI was longer with lock therapy for both non-tunneled catheters (31 ± 6 vs. 18 ± 3 days, $p < 0.001$) and tunneled catheters (96 ± 14 vs. 62 ± 10 days, $p < 0.001$). ICU admission occurred in 16 patients in the lock group and 38 in the no-lock group; overall mortality was 3.0% versus 7.6%, respectively, although the mortality difference was not statistically significant ($p = 0.221$). **Conclusion:** In this retrospective cohort, antibiotic lock therapy was associated with longer catheter-related infection-free duration and fewer severe hospitalization outcomes, while a statistically significant mortality benefit was not demonstrated. These findings support further prospective evaluation of antibiotic lock strategies in catheter-dependent hemodialysis populations.

KEYWORDS: catheter-related bloodstream infection; hemodialysis; antibiotic lock therapy; gentamicin; central venous catheter; bacteremia.

INTRODUCTION

Catheter-related bloodstream infection (CRBSI) remains a clinically important complication among patients who require central venous access for hemodialysis. Catheter-dependent patients are exposed repeatedly to vascular access manipulation, and the intraluminal catheter surface can support microbial adherence and biofilm formation. Once established, biofilm-associated infection may be difficult to eradicate with systemic antimicrobial therapy alone and can result in hospitalization, catheter loss, metastatic infection and death.

Both tunneled and non-tunneled catheters are used in clinical practice, although their indications and expected duration of use differ. Non-tunneled catheters are

commonly used when vascular access is required urgently or temporarily, whereas tunneled catheters are intended for longer-term access. In the present dataset, 88 patients had non-tunneled catheters and 70 had tunneled catheters, allowing description of the infection profile across both catheter types.

Antibiotic lock therapy involves instilling a concentrated antimicrobial solution into the catheter lumen after treatment and allowing it to dwell until the next use. The strategy is intended to achieve a high antimicrobial concentration at the site of intraluminal colonization while limiting systemic exposure. The Infectious Diseases Society of America has described antibiotic lock therapy as an option for selected long-term catheter

infections when catheter salvage is the goal, and notes that in hemodialysis patients the lock may be renewed after each dialysis session.^[1]

Gentamicin has been used in antimicrobial lock protocols because of its activity against a range of organisms implicated in catheter-related infections. Previous clinical literature has evaluated antibiotic lock protocols for dialysis catheter bacteremia and has highlighted the importance of pathogen, catheter type, and clinical severity when deciding whether catheter salvage is appropriate.^[2,3]

Despite published evidence, real-world comparisons of outcomes among culture-positive CRBSI patients managed with and without an antibiotic lock remain clinically relevant, particularly in settings where catheter access is limited and preservation of functioning access is important. The present study therefore evaluates the clinical profile, microbiological pattern, catheter characteristics and outcomes of culture-positive CRBSI patients treated at Gandhi Hospital during 2024–2025, with particular attention to outcomes associated with gentamicin lock therapy.

AIM

To study the clinical profile and outcomes of culture-positive catheter-related bloodstream infection with and without antibiotic lock therapy.

OBJECTIVES

- To describe the demographic and baseline clinical characteristics of patients with culture-positive CRBSI.
- To describe the distribution of culture-positive organisms causing CRBSI.
- To compare time to first CRBSI in tunneled and non-tunneled catheter groups according to antibiotic lock therapy status.
- To compare hospitalization for sepsis, mortality and catheter removal due to infection between patients managed with and without antibiotic lock therapy.
- To identify clinical factors associated with mortality among patients with culture-positive CRBSI.

MATERIALS AND METHODS

Study design and setting

This was a retrospective observational study conducted at Gandhi Hospital. The study included 158 patients with culture-positive catheter-related bloodstream infection who were admitted during the period from January 2024 to December 2025.

Study population

The study population comprised patients with culture-positive CRBSI identified in the hospital records during the study period. The supplied study document did not provide a separate list of inclusion and exclusion criteria; therefore, these criteria should be added from the original study protocol before journal submission.

Catheter groups

Patients were classified according to catheter type as having a non-tunneled catheter (n=88; 55.7%) or a tunneled catheter (n=70; 44.3%). Among tunneled-catheter patients, catheter duration was ≤1 month in 10 patients (14.3%), 1–6 months in 28 (40.0%), and >6 months in 32 (45.7%).

Antibiotic lock protocol

Gentamicin lock therapy was administered at the end of each hemodialysis session. The lock solution consisted of gentamicin sulfate at a concentration of 2–5 mg/mL (commonly 5 mg/mL), diluted in 0.9% normal saline. The volume used was equal to the internal volume of the catheter lumen, usually approximately 1.5–2.5 mL per lumen according to the supplied protocol. The lock was renewed after each dialysis session.

Clinical and laboratory variables

Variables available in the source dataset included age, sex, hemoglobin, total leukocyte count, platelet count, serum creatinine, catheter duration, catheter type, hemodialysis vintage in the catheter-specific tables, history of previous CRBSI, cause of kidney disease/renal failure in the non-tunneled group, culture-positive organism, time to first CRBSI, hospitalization for sepsis, ICU admission, mortality and catheter removal due to infection.

Outcome measures

- Primary outcome: time to first CRBSI as reported separately for tunneled and non-tunneled catheters.
- Secondary outcomes: hospitalization due to sepsis, ICU admission, mortality and catheter removal because of infection.
- Additional exploratory outcome: factors associated with mortality among culture-positive CRBSI patients.

Ethical considerations

Because this was a retrospective study involving human clinical records, the manuscript should include the Institutional Ethics Committee/Institutional Review Board approval statement and approval number from the original study records. The supplied document did not contain an ethics approval number or consent statement; these details must be inserted before submission.

RESULTS

Demographic and baseline characteristics

A total of 158 culture-positive CRBSI patients were included. The mean age was 54.96 ± 8.90 years. There were 107 male patients (67.7%) and 51 female patients (32.3%). Mean hemoglobin was 9.32 ± 0.99 g/dL, mean total leukocyte count was $11,576.19 \pm 2,778.78$ cells/mm³, mean platelet count was $212.59 \pm 57.07 \times 10^3$ /mm³ and mean creatinine was 5.97 ± 1.38 mg/dL. Mean catheter duration was 54.05 ± 42.89 days.

Table 1.

Characteristic	Value
Total patients	158
Age, mean $\pm$ SD (years)	54.96 $\pm$ 8.90
Male, n (%)	107 (67.7)
Female, n (%)	51 (32.3)
Hemoglobin, mean $\pm$ SD (g/dL)	9.32 $\pm$ 0.99
TLC, mean $\pm$ SD (cells/mm ³)	11,576.19 $\pm$ 2,778.78
Platelets, mean $\pm$ SD ($\times 10^3$ /mm ³)	212.59 $\pm$ 57.07
Creatinine, mean $\pm$ SD (mg/dL)	5.97 $\pm$ 1.38
Catheter duration, mean $\pm$ SD (days)	54.05 $\pm$ 42.89
Non-tunneled catheter, n (%)	88 (55.7)
Tunneled catheter, n (%)	70 (44.3)

Microbiological Profile

Gram-positive organisms accounted for 93 of 158 culture-positive infections (58.9%), while gram-negative organisms accounted for 57 (36.1%). *Staphylococcus aureus* was the most frequently reported organism, isolated in 46 patients (29.1%), followed by coagulase-

negative staphylococci in 38 (24.1%) and *Enterococcus* species in 9 (5.7%). Among gram-negative isolates, *Klebsiella pneumoniae* was most common (22; 13.9%), followed by *Escherichia coli* (17; 10.8%), *Pseudomonas aeruginosa* (12; 7.6%) and *Acinetobacter* species (6; 3.8%).

Table 2.

Organism	n	%
<i>Staphylococcus aureus</i>	46	29.1
Coagulase-negative staphylococci	38	24.1
<i>Enterococcus</i> species	9	5.7
Total gram-positive	93	58.9
<i>Klebsiella pneumoniae</i>	22	13.9
<i>Escherichia coli</i>	17	10.8
<i>Pseudomonas aeruginosa</i>	12	7.6
<i>Acinetobacter</i> species	6	3.8
Total gram-negative	57	36.1
Total	158	100

Tunneled-catheter subgroup

Among the 70 patients with tunneled catheters, the mean age was 49 $\pm$ 6 years. There were 44 males (62.9%) and 26 females (37.1%). Mean hemodialysis vintage was 121

$\pm$ 16 and mean catheter duration was 93 $\pm$ 12 days as reported in the source table. Twelve patients (17.14%) had a history of previous CRBSI.

Table 3.

Variable	Result
Number of patients	70
Age, mean $\pm$ SD (years)	49 $\pm$ 6
Male, n (%)	44 (62.9)
Female, n (%)	26 (37.1)
Hemodialysis vintage, mean $\pm$ SD	121 $\pm$ 16
Catheter duration, mean $\pm$ SD (days)	93 $\pm$ 12
Previous CRBSI, n (%)	12 (17.14)

Non-tunneled-catheter subgroup

Among the 88 patients with non-tunneled catheters, the mean age was 43 $\pm$ 4 years. There were 63 males (71.6%) and 25 females (28.4%). The reported catheter-related duration was 27 $\pm$ 6 days. Seventeen patients (19.31%) had previous CRBSI. The reported underlying clinical categories included recovering acute kidney injury in 40 patients (45.4%), acute kidney injury progressing to chronic kidney disease in 24 (27.3%), and CKD stage 5D in 20 (22.7%).

Table 4.

Variable	Result
Number of patients	88
Age, mean $\pm$ SD (years)	43 $\pm$ 4
Male, n (%)	63 (71.6)
Female, n (%)	25 (28.4)
Duration, mean $\pm$ SD (days)	27 $\pm$ 6
Previous CRBSI, n (%)	17 (19.31)
Recovering AKI, n (%)	40 (45.4)
AKI to CKD, n (%)	24 (27.3)
CKD 5D, n (%)	20 (22.7)

Comparison of outcomes with and without antibiotic lock therapy

In the reported comparison, patients receiving antibiotic lock therapy had a longer time to first CRBSI than those without lock therapy. For non-tunneled catheters, the

reported time to first CRBSI was 31 $\pm$ 6 days with lock versus 18 $\pm$ 3 days without lock ($p < 0.001$). For tunneled catheters, the corresponding values were 96 $\pm$ 14 versus 62 $\pm$ 10 days ($p < 0.001$).

Table 5.

Outcome	With lock	Without lock	P value
Time to 1st CRBSI — non-tunneled catheter (days)	31 $\pm$ 6	18 $\pm$ 3	<0.001
Time to 1st CRBSI — tunneled catheter (days)	96 $\pm$ 14	62 $\pm$ 10	<0.001
Sepsis hospitalization — non-ICU	50	54	0.004
Sepsis hospitalization — ICU	16	38	0.004
Mortality	2 (3.0%)	7 (7.6%)	0.170
Catheter removal due to infection — TCC	9/40	16/62	0.960
Catheter removal due to infection — NTC	24/26	27/30	0.920

Factors associated with mortality

Nine deaths were reported among the 158 patients. Mortality was significantly associated with age >60 years ($p=0.032$), non-tunneled catheter use ($p=0.041$), ICU admission ($p=0.001$), septic shock ($p<0.001$), gram-

negative infection ($p=0.018$), fungal infection ($p=0.004$), and previous CRBSI ($p=0.022$). No statistically significant association was reported for male sex ($p=0.421$) or absence of antibiotic lock therapy ($p=0.170$).

Table 6.

Factor	Deaths (n=9)	Survivors (n=149)	Mortality (%)	P value
Age >60 years	6	48	11.1	0.032
Male sex	7	100	6.5	0.421
Non-tunneled catheter	7	81	8.0	0.041
ICU admission	6	48	11.1	0.001
Septic shock	5	19	20.8	<0.001
Gram-negative infection	6	51	10.5	0.018
Fungal infection	2	6	25.0	0.004
No antibiotic lock therapy	7	85	7.6	0.170
Previous CRBSI	4	25	13.8	0.022

Overall outcome comparison

The outcome table included 92 patients in the no-lock group and 66 in the lock group. Survival was reported in 85 patients (92.4%) without lock and 64 (97.0%) with

lock. Death occurred in 7 patients (7.6%) without lock and 2 (3.0%) with lock. The difference in mortality between groups was not statistically significant ($p=0.221$).

Table 7.

Outcome	Without lock n (%)	With lock n (%)	P value
Alive	85 (92.4)	64 (97.0)	0.221
Death	7 (7.6)	2 (3.0)	0.221

DISCUSSION

The present retrospective observational study describes 158 culture-positive CRBSI episodes managed in a

hospital setting over a two-year period and compares reported outcomes according to the use of antibiotic lock therapy. The study population was predominantly male,

with a mean age of approximately 55 years, and more than half of the patients had non-tunneled catheters. The microbiological pattern was dominated by gram-positive organisms, with *Staphylococcus aureus* representing the single most common isolate.

The predominance of gram-positive organisms is clinically plausible in catheter-related bloodstream infection because staphylococci can adhere to catheter surfaces and participate in biofilm formation. In the present study, *S. aureus* and coagulase-negative staphylococci together accounted for 53.2% of all culture-positive isolates. Gram-negative organisms nevertheless constituted more than one-third of the isolates, with *K. pneumoniae* and *E. coli* being the leading gram-negative pathogens.

A major finding was the longer reported time to first CRBSI among patients receiving antibiotic lock therapy. The difference was observed in both catheter categories: 31 ± 6 versus 18 ± 3 days for non-tunneled catheters and 96 ± 14 versus 62 ± 10 days for tunneled catheters, with $p < 0.001$ for both comparisons. These findings suggest an association between the lock strategy and improved catheter infection-free duration. However, because the study is retrospective and the supplied material does not fully describe how patients were allocated to lock versus no-lock groups, the observed association should not be interpreted as proof of causation.

Clinical severity also appeared to differ between groups. The reported sepsis hospitalization counts showed fewer ICU admissions among patients who received lock therapy^[16] than among those without lock therapy^[38], with an overall p value of 0.004 in the supplied table. This observation may indicate a lower burden of severe sepsis among patients receiving the intervention, although differences in baseline severity, catheter type, comorbidity and treatment selection could contribute.

The mortality findings require cautious interpretation. The source dataset reported 2 deaths (3.0%) in the lock group and 7 deaths (7.6%) in the no-lock group. Although this numerical difference favors lock therapy, the reported p value was not statistically significant ($p = 0.221$ in the overall outcome table; $p = 0.170$ in the mortality-factor table). The small number of deaths substantially limits statistical power. Therefore, the study supports an association with catheter-related outcomes more strongly than it supports a mortality benefit.

Previous literature has emphasized that antibiotic lock therapy is a catheter-salvage strategy that should be selected according to clinical circumstances and pathogen. IDSA guidance recommends antibiotic lock in selected long-term catheter infections when salvage is the goal and recommends that it be used with systemic antimicrobial therapy rather than as sole treatment for CRBSI.^[1] The guideline also notes that catheter removal is generally recommended for *S. aureus* and *Candida*

infections rather than routine lock-based salvage.^[1] This distinction is important when interpreting the current study because the source dataset includes *S. aureus* as the most common organism, yet does not provide pathogen-specific treatment and catheter-removal details sufficient to determine whether management followed these principles in every case.

Poole et al. evaluated an antibiotic lock protocol for dialysis catheter-related bacteremia and demonstrated that outcomes varied according to the bacterial pathogen, supporting the concept that pathogen-specific management is important.^[2] Beathard and Urbanes reviewed infection associated with tunneled hemodialysis catheters and described antibiotic and antimicrobial locking solutions as potentially useful adjuncts while emphasizing limitations and concerns regarding *S. aureus* infection and catheter salvage.^[3] These observations are consistent with the need for careful patient selection in clinical practice.

The mortality-factor analysis in the present study identified several markers of severe disease. Septic shock showed the highest reported mortality percentage among the listed factors (20.8%) and was strongly associated with death ($p < 0.001$). ICU admission, age > 60 years, non-tunneled catheter use, gram-negative infection, fungal infection and previous CRBSI were also statistically associated with mortality. These findings indicate that outcomes are influenced by both host factors and infection severity, and that antibiotic lock therapy should not be viewed in isolation from the overall management of sepsis and catheter infection.

The findings should also be considered in the context of the retrospective design. Selection of patients for antibiotic lock therapy may have depended on catheter type, clinical stability, organism, catheter salvage considerations or clinician preference. The supplied dataset does not provide sufficient information to adjust for these potential confounders. In addition, the statistical methods, exact diagnostic criteria for CRBSI, systemic antibiotic regimens, timing of cultures, follow-up duration, adverse events and reasons for catheter removal were not provided in the source document. These issues should be clarified in the final submission.

Despite these limitations, the study provides useful real-world information from 158 culture-positive CRBSI patients and demonstrates a consistent association between antibiotic lock therapy and longer time to first CRBSI in both catheter categories. Prospective studies with predefined eligibility criteria, standardized systemic antimicrobial therapy, pathogen-specific analyses and multivariable adjustment would help determine the independent effect of antibiotic lock therapy on catheter survival, recurrent infection, hospitalization and mortality.

CONCLUSION

In this retrospective observational study of 158 patients with culture-positive CRBSI, antibiotic lock therapy was associated with a significantly longer time to first CRBSI in both non-tunneled and tunneled catheter groups. The lock group also had fewer ICU admissions and a numerically lower mortality rate, although the difference in mortality was not statistically significant. Mortality was associated with markers of older age, non-tunneled catheter use, ICU admission, septic shock, gram-negative or fungal infection and previous CRBSI. Overall, antibiotic lock therapy appears to be a potentially useful adjunct for selected catheter-dependent patients, particularly when catheter preservation is clinically appropriate. Prospective controlled studies are needed to establish its independent effect on infection recurrence, catheter survival and mortality.

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CONFLICT OF INTEREST

[The authors declare no conflict of interest.]

ETHICAL APPROVAL

[Insert Institutional Ethics Committee/IRB name, approval number and date.]

DATA AVAILABILITY

The data underlying this study are not publicly available because of institutional and patient confidentiality requirements. De-identified data may be made available from the corresponding author on reasonable request, subject to institutional approval and applicable ethical restrictions. Insert institutional policy statement regarding availability of de-identified data.

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