International Journal of Research in Medical Sciences
Ralte L et al. Int J Res Med Sci. 2025 Nov;13(11):4850-4856
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20253612

Original Research Article

Microbiological profile of central line-associated bloodstream infections at a tertiary care facility

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Received: 10 September 2025
Revised: 17 October 2025
Accepted: 27 October 2025

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ABSTRACT

Background: High-risk and critically ill patients admitted to the ICU often require catheter insertion for administering fluids, blood products, medications and performing hemodynamic monitoring. Healthcare-associated infections (HAIs) are common in the ICU due to prolonged hospital stays. Central line-associated bloodstream infections (CLABSI) are significant healthcare-associated infections that necessitate surveillance to decrease their occurrence. This study aims to identify the etiological agents and AST patterns of CLABSI in the Medicine ICU.
Methods: A hospital-based surveillance study was conducted from January to December 2023 in the medicine ICU. Blood samples were collected from suspected patients, processed, organisms isolated and their antibiotic susceptibility tested following our department's SOPs. CLABSI was diagnosed as per the AIIMS guidelines. CLABSI rates were calculated monthly as part of an HIC surveillance. IPC measures were implemented to reduce the CLABSI rate under surveillance.
Results: Out of 628 blood samples received from the medicine ICU, 178 (28.3%) were positive by culture and 450 were sterile. Of the 178 positive samples, 65 (10.35%) cases were HAI BSI, with 19 (3.02%) being CLABSI HAI and 46 (7.32%) non-CLABSI HAI. Among CLABSI HAI, Gram-negative bacteria (GNBs) are the most common organisms, accounting for 68.4% of isolates, while Gram-positive bacteria (GPBs) contribute 31.6%.
Conclusions: Excessive use of invasive procedures increases the risk of MICU patients becoming colonized with highly resistant bacteria. Identifying the range of bacteria causing BSI helps clinicians apply proper management strategies and antibiotic policies to improve patient outcomes.

Keywords: Antibiotic susceptibility testing, CLABSI, ICU

INTRODUCTION

CLABSI is a preventable healthcare-associated infection HAI that prolongs hospital stays and increases healthcare costs. To administer fluids, blood products, medications and nutritional solutions and to monitor hemodynamic, catheters are implanted.[1] Infections related to central venous catheters are classified as either CLABSI or "catheter-related bloodstream infection" (CRBSI), depending on whether the goal is infection detection or surveillance.[1] A laboratory-confirmed bloodstream infection must meet at least one of the following criteria. Detection of a recognized pathogen cultured from one or more blood samples and the pathogen is not associated with an infection at another site.[1] Presence of fever, chills and/or hypotension along with positive laboratory cultures from two or more blood samples drawn on separate occasions, which are not related to infection at another site and do not reflect contamination.[1] Bloodstream infection related to a central venous catheter constitutes one of the major healthcare-associated device infections.[1] As per CDC NHSN 2023, CLABSI accounted for about 20% of all hospital-acquired bloodstream infections.[2] The prevalence of HAI in sequence from most common to least common is as follows: CAUTI (32%), SSI (22%), VAP (15%), BSI (10%), gastrointestinal infections (9%), skin and soft tissue infections (5-10%).[2]

Primary bloodstream infections can be classified based on device association, either as CLABSI or non-central line-associated primary BSI.[2] ICU patients are susceptible to bloodstream infections due to the need for long-term central lines, highlighting the importance of surveillance to monitor their prevalence and implement reduction strategies. High rates of CLABSI in ICUs are linked to poor compliance with infection control practices. In recent years, the impact of CLABSI has gained more attention as it serves as a key indicator for shaping infection control policies, highlighting the need for strict adherence to IPC measures to reduce CLABSI.

This study aims to identify the range of bacteria causing CLABSI in the Medicine Intensive Care Unit and their antibiotic susceptibility patterns to help clinicians select appropriate antibiotics and implement effective management strategies and antibiotic policies to improve patient outcomes.

METHODS

A hospital-based CLABSI surveillance study was carried out from January 2023 to December 2023 at the Medicine Intensive Care Unit of Government Medical College, Chhatrapati Sambhajinagar (Aurangabad).

A total of 628 clinically suspected blood samples were received from the Medicine ICU during the surveillance period. Blood culture was done to confirm the presence of microorganisms in the bloodstream. Identification of pathogens was done by either conventional methods or the BacT / ALERT microbial detection system. In the study, blood samples were collected in BHI broth and the method used for identification was the conventional blood culture technique. Standard SOPs were followed for the identification and antibiotic susceptibility testing.

Inclusion criteria

Patients with hospital admission for >2 calendar days and with a provisional diagnosis of BSI based on clinical suspicion, in which a temporary central line placed for more than two calendar days from the event date, counting the placement day as day one, OR a temporary central line in place for more than two calendar days that was removed on the day of the event or the day before the event.[2]

Exclusion criteria

Patients with a central line but less than 2 calendar days of hospital admission.[2] Patients with a central line with a known focus of infection other than the central line.[3] Samples were collected before initiation of antimicrobial treatment. Two sets of blood cultures, each of 10-20 ml, were collected using two separate needles and syringes.

After the blood sample was received in BHI broth, the bottles were incubated at 37°C in an incubator. They were visually examined daily for the presence of any turbidity, hemolysis, gas production, pellicle formation, puffballs and clotting, as these changes could indicate microbial growth.

After 72 hours of incubation, the top of the bottle is cleaned with an ethanol-ether swab through the rubber cap. A sterile needle is then inserted and 1 mL of broth culture is withdrawn, which is inoculated onto sheep blood agar, MacConkey agar and chocolate agar. Blood and MacConkey agar are incubated overnight at 37°C under aerobic conditions, while chocolate agar is incubated in 5% CO_2 overnight. A Gram stain is prepared from the cultured colonies and biochemical reactions are performed based on the results of the Gram stain.

Antibiotic susceptibility testing was conducted using the Disk Diffusion method, known as the Modified Kirby-Bauer Disc Diffusion technique. The zones of inhibition were measured in millimetres with a scale and the antimicrobial agents were classified as sensitive, intermediate or resistant according to CLSI guidelines. Antifungal susceptibility was not performed in our study.

CLABSI cases were diagnosed according to the AIIMS guidelines and evaluated by the Infection Control Team. CLABSI rates were calculated at the end of each month as part of the HIC surveillance using the following formula[2]

CLABSI rate per 1000 CL days=

$$\frac{\text{Total number of CLABSI cases}}{\text{Total number of central line days}} \times 1000$$

The Institutional Ethics Committee approval was obtained for the study.

RESULTS

A total of 624 blood samples from patients with suspected bloodstream infections in the medicine ICU were analyzed, of which 178 (28.52%) tested positive by blood culture. Among these 178 positive results, 65 (10.42%) were hospital-acquired bloodstream infections, including 19 (3.04%) cases of CLABSI. The gender distribution among the 19 CLABSI cases shows that males account for 63.13% and females for 36.84%.

The age distribution of the 19 detected CLABSI cases shows that the largest number of CLABSI patients (6, 31.6%) is in the 41 to 50 years age group, followed by the 21 to 30 years age group (5, 26.3%). The age groups 31 to 40 and 61 to 70 years have the fewest CLABSI patients (1, 5.3%) and no patients are found in the less than 10-year and over 70-year age groups in the study.

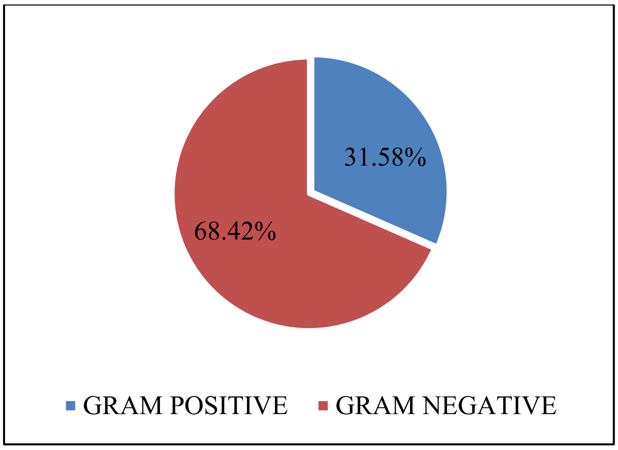

Figure 1: Percentage distribution of gram positive and gram negative isolates.

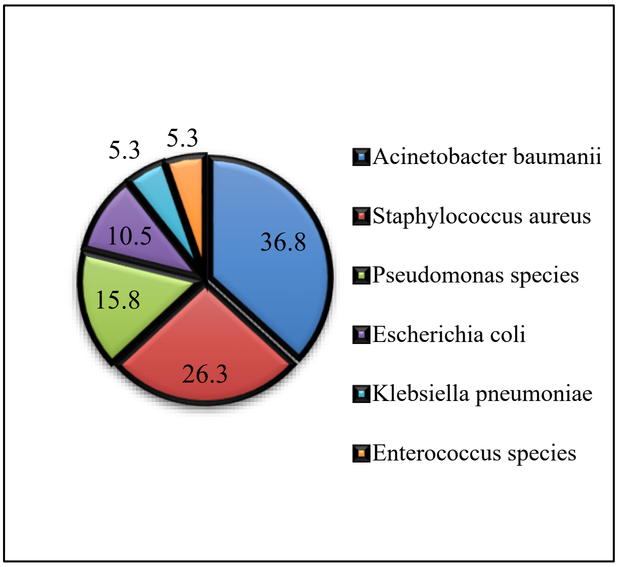

Figure 2: Percentage distribution of isolated bacteria from detected CLABSI cases.

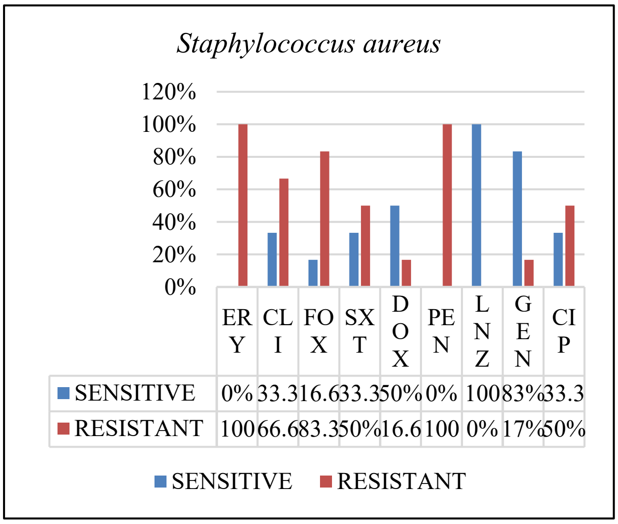

Figure 3: Percentage of antibiotic susceptibility of *Staphylococcus aureus*.

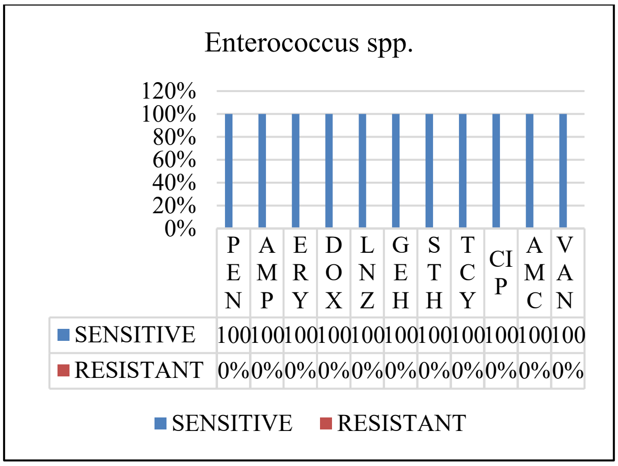

Figure 4: Percentage of antibiotic susceptibility of Enterococcus species.

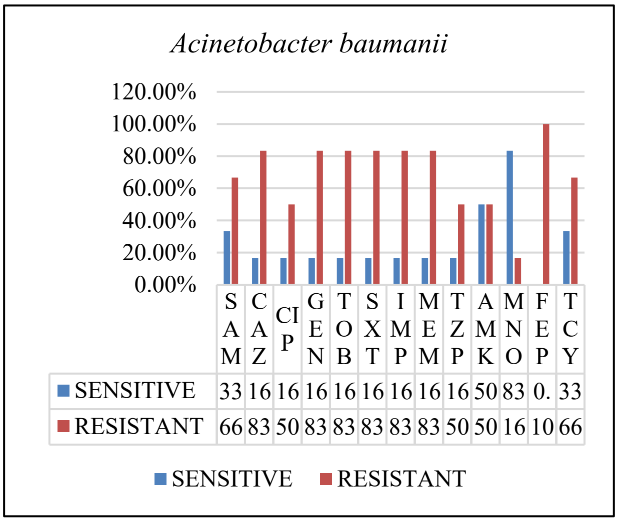

Figure 5: Percentage of antibiotic susceptibility of Acinetobacter baumanii.

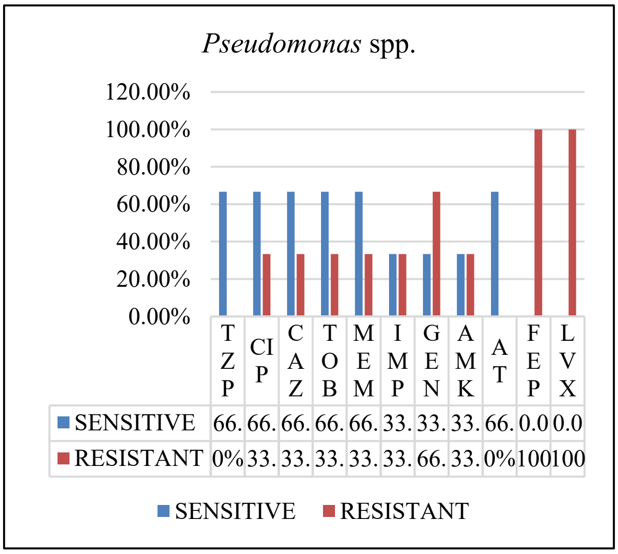

Figure 6: Percentage of antibiotic susceptibility of *Pseudomonas* species.

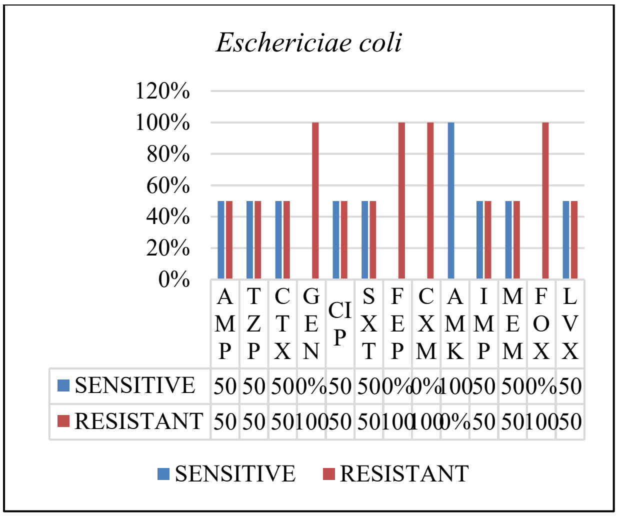

Figure 7: Percentage of antibiotic susceptibility of *Escherichia coli*.

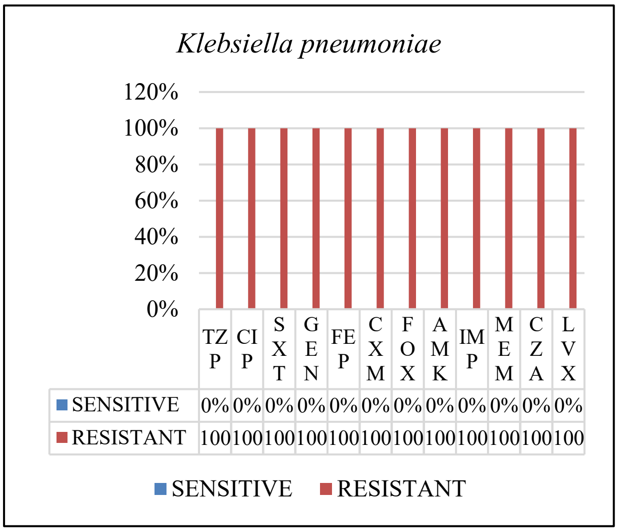

Figure 8: Percentage of antibiotic susceptibility of *Klebsiella pneumoniae*.

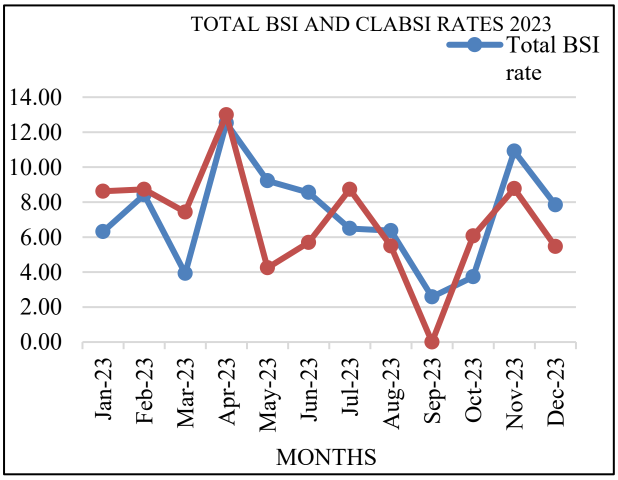

Figure 9: Total BSI and CLABSI rates during the study period.

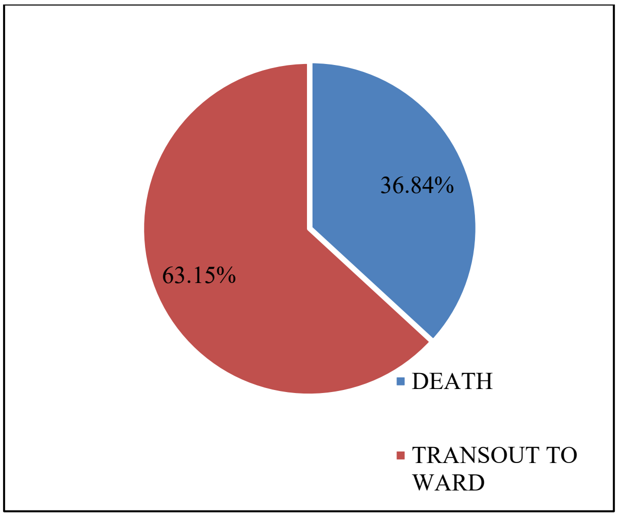

Figure 10: Prognosis of 19 detected CLABSI cases.

Figure 1 shows the percentage distribution of isolated pathogens into gram-positive and gram-negative organisms. Gram-negative bacteria are the most predominant organisms in our study, accounting for 68.42%, followed by gram-positive bacteria at 31.58% of the isolated pathogens.

Figure 2 represents the microbiological profile of causative microorganisms showing the percentage distribution of isolated bacteria from 19 detected CLABSI cases. GNB and GPC constitute 68.42% and 31.58% of the total isolates, respectively. Among GNB (68.42%), Acinetobacter baumannii is the predominant organism, accounting for 36.8% of the total isolates, followed by *Pseudomonas* species (15.8%), *Escherichia coli* (10.5%) and *Klebsiella pneumoniae* (5.3%). Among gram-positive cocci (31.58%), *Staphylococcus aureus* accounts for 26.3% of the total isolates and Enterococcus species make up 5.3% of the total isolates.

Gram-negative bacilli make up 68.4% (with *Acinetobacter baumannii* being the most common) and gram-positive cocci account for 31.6% (with *Staphylococcus aureus* being the most common). Of the five *Staphylococcus aureus* isolates, four (21.05%) are methicillin-resistant (MRSA).

Figure 3 depicts the percentage of antibiotic susceptibility of *Staphylococcus aureus*. All the isolates showed resistance to Penicillin and Erythromycin, 83.33% were resistant to Cefoxitin, 66.66% to Clindamycin, 50% to Ciprofloxacin and 16.66% to both Doxycycline and Gentamycin. Out of the five isolates of *Staphylococcus aureus* from 19 detected CLABSI cases, four isolates were methicillin-resistant. Figure 4 shows the percentage of antibiotic susceptibility of Enterococcus species. All the isolates of Enterococcus species (5.3%) exhibited 100% sensitivity to Vancomycin, Linezolid and other gram-positive antibiotics. Figure 5 shows the percentage of antibiotic susceptibility of *Acinetobacter baumanii*. Seven isolates of *Acinetobacter baumannii* were identified from 19 CLABSI cases, with 100% showing resistance to Cefepime and 83.33% resistant to each of Ceftazidime, Gentamicin, Tobramycin, Trimethoprim-sulfamethoxazole, Imipenem and Meropenem. Additionally, 66.66% were resistant to both Ampicillin-sulbactam and Tetracycline and 50% of the isolates showed resistance to each of Ciprofloxacin, Piperacillin, Tazobactam and Amikacin.

Figure 6 shows the percentage of antibiotic susceptibility of *Pseudomonas* species. All the isolates were resistant to Cefepime and Levofloxacin and 66.66% were resistant to Gentamicin. Additionally, 33.33% were resistant to each of Ciprofloxacin, Ceftazidime, Tobramycin, Meropenem, Imipenem and Amikacin. Three *Pseudomonas* spp. isolates were identified from 19 CLABSI cases.

Figure 7 shows the percentage of antibiotic susceptibility of *Escherichia coli*. Two *Escherichia coli* isolates were identified from 19 CLABSI cases, with 100% showing resistance to Gentamycin, Cefepime, Cefuroxime and Cefoxitin. Additionally, 50% exhibited resistance to Ampicillin, Piperacillin-tazobactam, Cefotaxime, Ciprofloxacin, Trimethoprim-sulfamethoxazole, Imipenem, Meropenem and Levofloxacin.

Figure 8 shows the percentage of antibiotic susceptibility of *Klebsiella pneumoniae*. All isolates of *Klebsiella pneumoniae* (5.3%) showed 100% resistance to Gram-negative antibiotics.

Figure 9 is a line graph showing the total bloodstream infections and CLABSI rates throughout our study period, from January 2023 to December 2023.

An average rate of 5% was maintained during the first three months, i.e., from January to March 2023. In April, a sudden surge of 13% was detected, triggering an alarm, for which the root cause analysis was discussed by the faculty and staff of the Medicine Department and the Hospital Infection Control (HIC) Team. Subsequently, the HIC team implemented bundle care more stringently and conducted repeated infection control training for the newly posted healthcare workers. Following the post-implementation of strict bundle care into practice in the MICU, the CLABSI rate improved by dropping to 4% in May and 5% by the end of our study period, December 2023.

Figure 10 shows the outcome of patients from 19 detected CLABSI cases. Twelve patients (63.15%) were transferred to the ward after a good prognosis, whereas seven patients (36.84%) died during our study period in the surveillance unit.

DISCUSSION

Central venous catheters (CVCs) are widely used in modern healthcare globally.[1] However, their use carries a risk of bloodstream infections caused by microorganisms that colonize either the external surface of the device or the fluid pathway, especially during insertion or subsequent manipulation.[1]

In our study, the gender distribution of detected CLABSI patients is 36.84% and 63.13% for males and females, respectively; whereas in Patel et al, it is 46.61% and 53.39% for males and females, respectively.[4] Moreover, in other studies, such as those by Bhatawadekar et al, Chawda et al, Gill et al and Gohel et al, the ratio of males to females is approximately 2:1. In contrast, our study found a ratio of roughly 1:2.[1,5-7]

The highest number of patients, i.e., 6 out of 19 detected CLABSI cases (31.57%), falls within the age group of 41-50 years, whereas in other studies like Bhatawadekar et al and Darji et al the maximum number of CLABSI cases occurs in the 50-60 years and 50-74 years groups, respectively.[1,8]

In the study, the identified pathogens included 13 GNB (68.4%) and 6 GPC (31.6%), with the most common being *Acinetobacter baumannii* (7, 36.8%); similar findings were reported in Lin et al.[9] Of the 6 (31.6%) GPC, we isolated 5 (26.3%) *Staphylococcus aureus* and 1 (5.3%) Enterococcus species. Among the 5 (26.3%) *Staphylococcus aureus*, 4 (21.05%) were methicillin-resistant.

Gram-positive bacteria

In the study, GPC accounted for 31.58%, which is similar to the findings of Patel et al and Darji et al who reported 32.5%; however, Nazeena et al reported GPC at 22%.[3,4,8] The findings show that all isolates of *Staphylococcus aureus* (Figure 3) and Enterococcus sp. (Figure 4) exhibit 100% sensitivity to Linezolid, which aligns with other studies such as Bhatawadekar et al, Patel et al, Chawda et al, Gill et al, Bhatnagar et al and Khodare et al.[1,4-6,10,11]

Meanwhile, in the study by Wasi et al *Staphylococcus aureus* shows 50% sensitivity to linezolid.[12] In our study, the isolates of *Staphylococcus aureus* show 83% sensitivity to Gentamicin (Figure 3), while findings by Chawda et al and Wasi et al, show 99% and 50% sensitivity to Gentamicin, respectively.[5,12] Moreover, in our study, *Staphylococcus aureus* isolates show 100% resistance to Penicillin, whereas in Gill et al and Bhatnagar et al, they show 76.92% and 85% resistance, respectively.[6,10]

According to the study, isolates of Enterococcus sp. (Figure 4) show 100% sensitivity to Vancomycin, which aligns with the findings of Gill et al and Bhatnagar et al, whereas Patel et al, report 89.4% sensitivity to Vancomycin; meanwhile, Khodare et al and Wasi et al, respectively indicate that 50% of Enterococcus sp. isolates are sensitive to Vancomycin.[4,6,10-12] In contrast, the study found that all Enterococcus sp. isolates are sensitive to Vancomycin.

Gram-negative bacteria

In our study, GNB makes up 68.4% of the isolated pathogens, which is similar to the findings of Patel et al and Darji et al where GNB accounts for 67.5%.[4,8] Moreover, Nazeema et al and Khodare et al,'s findings also show GNB as the main organisms, contributing to 78% and 86% of the isolates, respectively, which is higher than our results.[3,11] Additionally, other studies, such as those by Patel et al, Chawda et al, Khodare et al and Lin et al report gram-negative organisms as the predominant bacteria, followed by gram-positive bacteria.[4,5,9,11] According to data from developing countries, most bacteria causing CLABSIs are gram-negative and the incidence of these infections has been increasing recently, as noted by Marcos et al.[13]

Among the GNB isolates from our findings (as shown in Figure 2), seven isolates (36.8%) are *Acinetobacter baumannii*, three isolates (15.8%) are *Pseudomonas* species, two isolates (10.5%) are *Escherichia coli* and one isolate (5.3%) is *Klebsiella pneumoniae*. In our study, *Acinetobacter baumannii* (36.8%) is the most common organism, which is similar to the findings of Wasi et al, where Acinetobacter baumannii also accounts for 39.5%.[12] In contrast, Nazeema et al and Gohel et al,'s studies identified Escherichia coli as the most prevalent pathogen among detected CLABSI cases.[3,7]

In the study (Figure 5), 50% of isolated Acinetobacter baumannii were sensitive to Amikacin, 33.33% were sensitive to Ampicillin and 16.66% each were sensitive to Imipenem and Piperacillin/tazobactam. In contrast, in Ujesh et al, 66.66% were sensitive to each of Amikacin, Imipenem, Piperacillin/tazobactam and Ampicillin-sulbactam.[14] The National Nosocomial Infection Surveillance System reported a significant increase in the number of Acinetobacter among all the gram-negative aerobes in Wasi et al.[12] In the study, isolates of *Pseudomonas* species show 100% resistance to Cefepime (Figure 6), which aligns with the 97.56% resistance reported by Bhatnagar et al.[10] The results indicate no resistance to Piperacillin/tazobactam and 33.33% resistance to Imipenem and Meropenem, respectively. This is similar to the findings of Gohel et al where *Pseudomonas* species show the least resistance to carbapenems and Piperacillin/tazobactam.[7]

In the findings, *Escherichia coli* constitutes 10.5% of the isolates (Figure 7), which is precisely similar to Ujesh et al, in which all the isolates were resistant to Imipenem and Piperacillin/tazobactam.[14] In contrast, only 50% of the isolates were resistant to both in our study. According to the study (Figure 8), all isolated strains of *Klebsiella pneumoniae* were resistant to all the drugs. In contrast, Ujesh et al,'s findings indicate that all the isolated strains were sensitive to Amikacin, Meropenem, Piperacillin/tazobactam, Levofloxacin and Ertapenem.[14] Bhatnagar et al results show resistance rates of 79.49% and 76.92% to Cefepime and Cefotaxime, respectively, while our study shows 100% resistance to both drugs.[10] Improper adherence to IPC measures and the unnecessary use of antibiotics for extended and inappropriate durations may contribute to multidrug resistance in the isolated organisms.

An average rate of 5% was maintained during the first three months, from January to March 2023 (Figure 9). In April, a sudden surge of 13% was detected, triggering an alarm; the root cause analysis was discussed by the faculty and staff of the Medicine Department and the Hospital Infection Control Team, leading to more stringent implementation of bundle care in the MICU.

Nineteen CLABSI cases were identified from 2478 central line days and 9084 patient days in our surveillance unit. The overall average CLABSI rate was 6.85 per 1000 central line days. The baseline CLABSI rate in various ICUs is reported as 6.4 per 1000 central line days by Nazeena et al.[3] The mortality rate in our study is 36.84% and the survival rate is 63.15% (Figure 10) in contrast, in Ujesh et al the mortality rate is 5.3% and the survival rate is 94.7%.[14]

This study has limitations like it was conducted exclusively in the Medicine ICU and the blood samples collected were from adults only. Therefore, the findings are applicable only to adults, excluding neonates and pediatric groups.

CONCLUSION

Rising rates of CLABSI continue to be a significant challenge for healthcare facilities, even with the adoption of evidence-based practices. Active involvement of clinicians in the early diagnosis of bloodstream infections by following aseptic techniques when collecting blood samples, implementing infection prevention and control (IPC) measures such as insertion and maintenance bundles and practicing proper hand hygiene can help reduce morbidity and mortality linked to CLABSI. Using appropriate antibiotics based on culture reports from the Microbiology department can also improve patient outcomes by timely initiation of anti-microbial drugs.

More emphasis on regular educational programs and training on IPC measures, along with their surveillance, must be conducted to maintain the bundle care compliance and hence, reduce the hospital-acquired infection rates.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Bhatawadekar SM, Arunima, Lahiri KK. Bacterial profile of central line associated blood stream

infections in I.C.U patients from tertiary care hospital. IP Int J Med Microbiol Trop Dis. 2025;4(1):31-5.
2. Franklin D. COVID-19 vaccination coverage, and rates of SARS-CoV-2 infection and COVID-19–associated hospitalization among residents in nursing homes—National Healthcare Safety Network, United States, October 2023–February 2024. MMWR. Morbidity and Mortality Weekly Report. 2024;73.
3. Tabaseera N, Hanumantha S. Catheter associated blood stream infection (CLABSI)-bacteriological profile and antibiotic susceptibility pattern in nnicu of a tertiary care hospital in Andhra Pradesh, India. Int J Curr Microbiol Appl Sci. 2018;7:3935-41.
4. Patel R, Jain MR. Bacteriological profile and antibiotic sensitivity pattern of isolates from blood culture in suspected septicemic patients attending tertiary care hospital. IP Int J Med Microbiol Trop Dis. 2025;5(4):198-203.
5. Chawda H, Mistry M, Parmar T. A study of microbiological profile and antibiotic susceptibility pattern of the organisms isolated from blood stream infection in patients of critical care units in tertiary care hospital in Western India. IP Int J Med Microbiol Trop Dis. 2025;5(2):83-6.
6. Gill MK, Sharma S. Bacteriological profile and antibiotic resistance pattern in blood stream infection in critical care units of a tertiary care hospital in North India. Indian J Microbiol Res. 2025;3(3):270-4.
7. Gohel K, Jojera A, Soni S, Gang S, Sabnis R, Desai M. Bacteriological profile and drug resistance patterns of blood culture isolates in a tertiary care nephrourology teaching institute. Biomed Res Int. 2014;4:153747.
8. Darji SM, Patel N. Central line associated blood stream infection: microbiological profile and its antimicrobial susceptibility pattern at tertiary care centre. J Pure Appl Microbiol. 2023;17(2):911-8.
9. Lin WP, Chang YC, Wu UI, Hung MC, Chuang PY, Wang JT, et al. Multimodal interventions for bundle implementation to decrease central line-associated bloodstream infections in adult intensive care units in a teaching hospital in Taiwan, 2009-2013. J Microbiol Immunol Infect. 2018;51(5):644-51.
10. Bhatnagar R, Patel P. Study of antimicrobial resistance pattern in blood isolates from critical care unit at a Tertiary Care hospital, Udaipur, Rajasthan. Indian J Microbiol Res. 2025;5(1):61-5.
11. Khodare A, Kale P, Pindi G, Joy L, Khillan V. Incidence, microbiological profile and impact of preventive measures on central line-associated bloodstream infection in liver care intensive care unit. Indian J Crit Care Med. 2020;24(1):17-22.
12. Wasi S, Daga MK, Mawari G, Kumar N, Sharma U, Hussain M, et al. Current Pattern and Clinico-Bacteriological Profile of Healthcare Associated Infections in an ICU Setting: A Study from a Tertiary Care Centre in Delhi. J Adv Res Med. 2022;9(1):1-10.
13. Marcos M, Soriano A, Iñurrieta A, Martínez JA, Romero A, Cobos N, et al. Changing epidemiology of central venous catheter-related bloodstream infections: increasing prevalence of Gram-negative pathogens. J Antimicrob Chemother. 2011;66(9):2119-25.
14. Ujesh SN, Jayaprada R, Ramakrishna N, Sharma KK, Rao MH, Samantaray A. A study of microbiological profile and its antimicrobial susceptibility patterns related to central line-associated bloodstream infections in respiratory intensive care unit in a tertiary care hospital. J Clin Sci Res. 2020;9(1):25-30.

Cite this article as: Ralte L, Iravane JA, Harbade MS, Onkari A. Microbiological profile of central line-associated bloodstream infections at a tertiary care facility. Int J Res Med Sci 2025;13:4850-6.