ASIAN JOURNAL OF PHARMACEUTICAL AND CLINICAL RESEARCH

INNOVARE ACADEMIC SCIENCES
Knowledge to Innovation

Vol 17, Issue 11, 2024

Online - 2455-3891
Print - 0974-2441

Research Article

BLOODSTREAM INFECTIONS AND ITS ANTIBIOGRAM OF INTENSIVE CARE UNITS IN A TERTIARY CARE HOSPITAL OF CENTRAL INDIA

SHRUTI ASATI[1], MAMTA GAUR[1], VIJAYAKUMAR[2], SONIA SHARMA BHARTY[3]*

[1]Department of Microbiology, NSCB Medical College, Jabalpur, Madhya Pradesh, India. [2]Department of School of Excellence in Pulmonary Medicine, NSCB Medical College, Jabalpur, Madhya Pradesh, India. [3]Department of Microbiology, School of Excellence in Pulmonary Medicine, NSCB Medical College, Jabalpur, Madhya Pradesh, India.
*Corresponding author: Sonia Sharma Bharty; Email: sonia.sharma.bharty@gmail.com

Received: 2 September 2024, Revised and Accepted: 14 October 2024

ABSTRACT

Objective: To perform bacteriological analysis and to study drug susceptibility patterns of isolates from bloodstream infections.

Methods: This retrospective study was conducted in the microbiology department of NSCB Medical College, Jabalpur, spanning from July 2023 to December 2023. The study included blood culture samples from all adult intensive care unit patients of the medical college. Blood samples were collected with aseptic guidelines and cultured for 7 days. Growths were identified using standard biochemical tests and subjected to sensitivity testing according to Modified Kirby-Bauer's disk diffusion method. Data for the source of blood collection and duration of incubation were noted and compared.

Results: A total of 100 (21.7%) pathogens were isolated from 460 bacteremia suspect patient blood specimens. *Pseudomonas* spp. Were predominant organisms recovered followed by *Klebsiella* spp. and *Staphylococcus aureus*, coagulase-negative staphylococci, and *Acinetobacter* spp. were the primary pathogens isolated. Carbapenems, glycopeptides, and aminoglycosides were the most effective drugs for treating bacteremia.

Conclusions: Early diagnosis and proper antimicrobial therapy lead to successful treatment of sepsis and decreased morbidity and mortality. Antibiogram of a particular area helps in rationalizing verified treatment strategies.

Keywords: Bacteremia, Multidrug resistant, Bacterial isolates.

 DOI: http://dx.doi.org/10.22159/ajpcr.2024v17i11.52068. Journal homepage: https://innovareacademics.in/journals/index.php/ajpcr

INTRODUCTION

Bloodstream infections (BSI) are broadly defined as the presence of viable microorganisms in the blood, which can cause inflammation in the host, alter clinical and hemodynamic properties, and lead to morbid consequences [1]. Patients with bacteremia are mainly treated with antimicrobial therapy, alongside management of its consequences (e.g., shock or metastatic suppurative complications), and surgical treatment of infection sites (e.g., debridement, abscess drainage, or removal of intravascular devices) when appropriate [2].

Health-care associated (HCA) BSIs are associated with increased incidence of multi-drug resistant microorganisms, such as Methicillin-resistant *Staphylococcus aureus*, extended-spectrum beta-lactamase producing Enterobacteriaceae, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa*. The antimicrobial resistance profile of HCA BSI depends on local epidemiology [2].

In recent years, clinicians have observed a growing incidence of BSIs caused by bacteria resistant to commonly used antimicrobials [3]. A multidrug-resistant (MDR) microorganism is defined as an isolate with non-susceptibility to at least one agent in three or more antimicrobial categories. Extensively drug-resistant (DR) microorganisms exhibit susceptibility to only one or two antimicrobial categories, whereas pan-DR isolates are resistant to all agents across all antimicrobial categories [4].

In India, nearly 200,000 cases of BSI occur annually with a mortality rate of 20–50%. About 5% of all patients admitted to intensive care units (ICUs) develop BSI as a complication of serious illness [6]. HCA risk factors for BSIs include prolonged antibiotic therapy in ICU and HDU patients due to extended hospital stays, immunological deficiencies, old age, children, acute diseases, surgery, trauma, and, notably, in primary BSI, the presence of a central line shows a specific association of 87% [7].

Understanding the antimicrobial resistance patterns of pathogens in a particular hospital is crucial for the judicious use of antibiotics, thereby preventing the emergence of antibiotic resistance [8,9]. This underscores the significance of systematic surveillance of the causes of BSI to monitor the range of bacterial infections and their resistance patterns in specific areas. Clinicians not only require this data to be informed about emerging MDR strains spreading in the community but also to initiate effective empirical therapy for life-threatening infections [10].

Therefore, formulating a local antibiotic policy based on the antibiogram of the area is essential to guide intensivists and physicians in the initial selection of antibiotics for promptly treating seriously ill patients, aiming to significantly reduce morbidity and mortality. In this study, we aimed to examine the frequent microorganisms causing BSI and their antimicrobial susceptibility patterns among ICU patients at a tertiary care center in Madhya Pradesh.

Aims and objectives

1. To describe the profile of isolates causing BSIs in cases of bacteremia and septicemia.
2. To determine the antibiotic susceptibility pattern of these isolates.

METHODS

This retrospective study was conducted in the microbiology department of NSCB Medical College, Jabalpur, spanning from July 2023 to December

2023. The study included blood culture samples from all adult ICU patients of the medical college. Contaminants, mixed bacterial growths, and repeated positive cultures from the same patient were excluded.

Sample processing

Blood sample bottles were collected from patients as per physician instructions before administering any antibiotics. Patient details were recorded in registers, and samples from adult ICU patients were processed. For negative samples, blood culture bottles remained in the incubator and were reported negative after 5 days. For positive samples, the blood culture bottle was removed from the system and conventionally inoculated on blood agar and MacConkey agar, incubated aerobically at 37°C. The resulting growth was identified using colony morphology, Gram stain, and standard biochemical tests.

Antimicrobial susceptibility testing

Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method and interpreted according to Clinical and Laboratory Standards Institute guidelines 2019. The following antimicrobials were tested:

- For Gram-positive bacterial isolates: Erythromycin (E), Penicillin (P), Cefoxitin (CX), Co-trimoxazole (COT), Clindamycin (CL), Doxycycline (DO), Linezolid (LZ), Vancomycin (VA), Gentamicin (GM).
- For Gram-negative bacterial isolates: Amikacin (AK), Gentamicin (GM), Augmentin (AG), Ceftriaxone (CTR), Ceftazidime (CAZ), Cefepime (CP), Piperacillin-Tazobactam (PT), Ciprofloxacin (CIP), Levofloxacin (LE), Imipenem (IM), Meropenem (MP), Trimethoprim-sulfamethoxazole (COT), Tigecycline (TG), Colistin (COL).

Escherichia coli (ATCC 25922), *Staphylococcus aureus* (ATCC 25923), and *P. aeruginosa* (ATCC 27853) were used as reference strains for culture and susceptibility testing.

Data analysis

Data analysis was conducted using SPSS software.

Ethical considerations

Ethical approval for this study was granted by the institutional ethical committee.

RESULTS

Among a total of 460 samples received from adult ICUs during July 2023 to December 2023, 100 (21.7%) were positive for isolates. Of these, *P. aeruginosa* accounted for 39 (39.0%) isolates, while the remaining isolates included *S. aureus* 19 (19.0%), coagulase-negative staphylococci (CONS) 4 (4.0%), *E. coli* 6 (6.0%), *Klebsiella pneumoniae* 28 (28.0%), and *Acinetobacter* spp. 4 (4.0%) (Fig. 1).

The present study showed a higher incidence of BSI in males (58.3%) compared to females (41.6%), as shown in Table 1. The majority of patients were in the age group above 55 years, comprising 46.9% of the total, as indicated in Table 1.

According to Table 2, which displays the antimicrobial sensitivity pattern of *S. aureus* isolates obtained from the Adult ICU, there were a total of 23 Gram-positive isolates, comprising 19 *S. aureus* and 4 CONS. *S. aureus* exhibited 100% resistance to penicillin, followed by trimethoprim-sulfamethoxazole (79%) and erythromycin (74%). However, it showed the least resistance to vancomycin (0%), linezolid (5.3%), and doxycycline (26.3%). Gentamicin demonstrated 47.4% resistance.

Similarly, CONS displayed maximum resistance to penicillin and doxycycline, while showing the least resistance to linezolid, vancomycin, cefoxitin, and clindamycin.

Table 3 shows the antimicrobial sensitivity pattern of Gram-negative isolates. Non-fermenters, including *P. aeruginosa* (39) and *Acinetobacter* spp. (4), contributed more to BSI than fermenters, such as *E. coli* and *Klebsiella* spp. with *Klebsiella* spp. (28) predominating over *E. coli* (6).

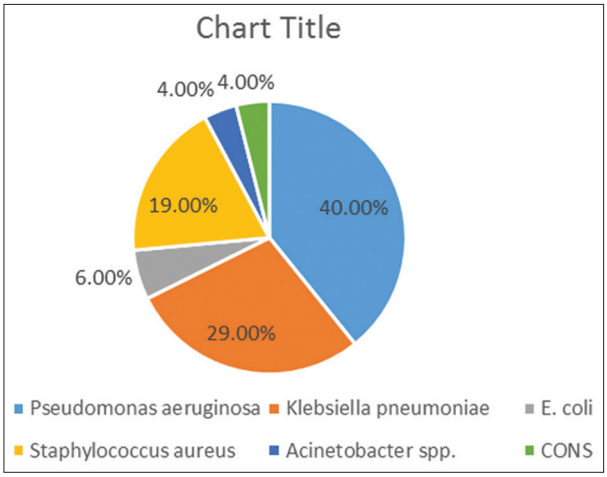

Fig. 1: Different isolates from the blood culture samples

Table 1: Age and gender-wise distribution of positive samples

Age group (years)	Male		Female		Total	
	Number	%	Number	%	Number	%
16–35	12	20.7	8	19.0	20	20.0
36–55	19	32.7	14	33.3	33	33.0
>55	27	46.5	20	47.6	47	47.0
Total	58	58.0	42	42.0	100	100

Non-fermenters demonstrated maximum resistance to co-trimoxazole, amoxiclav, and ceftriaxone, followed by first-line fluoroquinolones and aminoglycosides. They exhibited the least resistance to colistin, tigecycline, and carbapenems.

Among *Enterobacteriaceae* isolates, *Klebsiella* spp. showed maximum resistance to amoxiclav and third-generation cephalosporins. In contrast, *E. coli* showed maximum resistance to fluoroquinolones. Both isolates displayed the least resistance to colistin, tigecycline, and carbapenems.

DISCUSSION

BSI poses significant health challenges and contributes to increased resource utilization, morbidity, and mortality, particularly among critically ill patients in ICUs. This study aims to delineate the spectrum of pathogens causing BSI and their antimicrobial resistance patterns in ICU settings.

The critical issue of BSI, which can progress to life-threatening sepsis, underscores the importance of timely isolation, identification, and antimicrobial susceptibility testing of bloodborne pathogens. Diagnostic microbiology labs bear increasing responsibility in this regard [11].

Research consistently shows a strong correlation between delays in initiating effective therapy and higher in-hospital mortality rates from septic shock. Literature suggests that each hour of delay in treatment initiation correlates with an 8% decrease in survival [12].

This study contributes by examining the bacteriological profiles of blood cultures and assessing antimicrobial resistance patterns. Understanding these dynamics can guide the management of life-threatening sepsis stemming from BSIs.

In our study, the culture positivity rate was 21.7%, consistent with rates reported in similar studies from India and abroad [12-17]. Variations in culture positivity rates across studies can be attributed to demographic factors and differences in sampling [18-20].

Table 2: Antimicrobial sensitivity pattern of *Staphylococcus aureus* isolates

Antibiotics	*Staphylococcus aureus* isolates (n=19)		Coagulase-negative *Staphylococcus*-CONS (n=4)	
	Number of sensitive isolates (n)	Percentage of sensitive isolates (%)	Number of sensitive isolates (n)	Percentage of sensitive isolates (%)
Erythromycin	05	26	2	50
Penicillin	0	00	1	25
Cefoxitin	06	31.5	4	100
Trimethoprim- sulfamethoxazole	04	21	3	75
Clindamycin	07	36.8	4	100
Doxycycline	14	73.7	2	50
Linezolid	18	94.7	4	100
Vancomycin	19	100	4	100
Gentamicin	10	52.6	3	75

Table 3: Antimicrobial sensitivity pattern of Gram-negative isolates

Antibiotics	*Escherichia coli* n=6 (%)	*Klebsiella* spp. n=28 (%)	*Pseudomonas aeruginosa* n=39 (%)	*Acinetobacter* spp. n=4 (%)
Amikacin	04 (66.7)	08 (28.5)	16 (41)	01 (25)
Gentamicin	02 (33.3)	04 (14.3)	11 (28)	00 (00)
Amoxicillin-clavulanate	02 (33.3)	01 (03.5)	00 (00)	00 (00)
Ceftazidime	04 (66.7)	03 (10.7)	09 (23.1)	00 (00)
Ceftriaxone	01 (16.7)	01 (3.5)	00 (00)	00 (00)
Cefoperazone	02 (33.3)	02 (7.1)	11 (28)	02 (50)
Cefepime	03 (50)	03 (10.7)	17 (43)	02 (50)
Piperacillin-tazobactam	04 (66.7)	19 (67.8)	30 (76.9)	02 (50)
Ciprofloxacin	0 (00)	09 (32.1)	12 (30.7)	00
Levofloxacin	01 (16.7)	08 (28.5)	17 (43)	00
Meropenem	05 (83.3)	17 (60.7)	31 (79.4)	03 (75)
Imipenem	03 (50)	16 (57.1)	33 (84.6)	02 (50)
Trimethoprim-sulfamethoxazole	03 (50)	08 (28.5)	00 (00)	00 (00)
Tigecycline	06 (100)	23 (82.1)	36 (92.3)	04 (100)
Colistin	06 (100)	26 (92.8)	38 (97.4)	04 (100)

Our findings indicate a slightly higher culture positivity among males (58%) compared to females (42%), aligning with previous research.

Gram-negative organisms predominated over Gram-positive organisms in our study. Monomicrobial growth was observed in all cultures, with *S. aureus* and CONS among Gram-positive isolates, and *E. coli*, *Klebsiella* spp., *P. aeruginosa*, and *Acinetobacter* spp. among Gram-negative isolates.

Among Gram-positive isolates, *S. aureus* exhibited high sensitivity to vancomycin (0%), linezolid (5.3%), and doxycycline (26.3%), consistent with existing literature [21,22].

Similarly, CONS showed maximum sensitivity to linezolid, vancomycin, cefoxitin, and clindamycin.

Among Gram-negative non-fermenters, *Pseudomonas* spp. demonstrated maximum sensitivity to colistin, tigecycline, and carbapenems. Fermenters, such as *Klebsiella* spp. and *E. coli* also showed high sensitivity to these antibiotics, in line with previous studies [23].

CONCLUSION

Effective management of antibiotic-resistant pathogens in ICUs requires strict adherence to infection control protocols and judicious use of antibiotics. Antibiotic stewardship programs play a crucial role in optimizing antibiotic use, slowing the emergence of resistance, and reducing treatment costs.

The dominance of multi-drug resistant Gram-negative bacilli in ICUs poses significant therapeutic challenges. Surveillance of BSI and hospital antibiograms is essential for guiding effective treatment strategies. With few new antimicrobials in development, careful antibiotic selection and stewardship are imperative to combat emerging resistance and improve patient outcomes.

Implementing multidisciplinary approaches, including robust infection control measures and antibiotic stewardship, is essential to mitigate BSI incidence and resistance emergence. This study underscores the urgent need for responsible antibiotic usage to preserve treatment efficacy in ICU settings.

AUTHORS CONTRIBUTIONS

Research Concept- Dr. Sonia Sharma Bharty. Research design- Dr. Sonia Sharma Bharty and Dr. Shruti Asati. Supervision- Dr. Mamta Gour. Materials and Data collection- Dr. Shruti Asati. Data analysis and interpretation- Dr. Shruti Asati. Writing article- Dr. Sonia Sharma Bharty and Dr. Vijayakumar. Article editing- Dr. Sonia Sharma Bharty and Dr. Vijayakumar. Final approval- Dr. Mamta Gaur and Dr. Shruti Asati.

CONFLICTS OF INTERESTS

Nil.

AUTHORS FUNDING

Nil.

REFERENCES

1. Viscoli C. Bloodstream infections: The peak of the iceberg. Virulence. 2016;7(3):248-51.
2. Timsit JF, Soubirou JF, Voiriot G, Chemam S, Neuville M, Mourvillier B, *et al*. Treatment of bloodstream infections in ICUs. BMC Infect Dis.

2014;14:489.
3. Ammerlaan H, Harbarth S, Buiting A, Crook DW, Fitzpatrick F, Hanberger H, *et al*. Secular trends in nosocomial bloodstream infections: Antibiotic-resistant bacteria increase the total burden of infection. Clin Infect Dis. 2013;56(6):798-805.
4. Magiorakos AP, Srinivasan A, Carey R, Carmeli Y, Falagas ME, Giske CG, *et al*. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: An international expert proposal for interim standard definitions for acquired resistance. Clin Microbiol Infect. 2012;18(3):268-81.
5. Vanitha RN, Kannan G, Venkata NM, Vishwakath D, Nagesh VD, Yogitha M. A retrospective study on blood stream infections and antibiotic susceptibility patterns in a tertiary care teaching hospital. Int J Pharm Pharm Sci. 2012;4(1):543-8.
6. Timsit JF, Soubirou JF, Voiriot G, Chemam S, Neuville M, Mourvillier B, *et al*. Treatment of bloodstream infections in ICUs. BMC Infect Dis. 2014;14:489.
7. Rosineide MR, Claudete F, Paulo P. Nosocomial bloodstream infections: Organisms, risk factors and resistant phenotypes in the Brazilian University Hospital. Braz J Infect Dis. 2007;11(3):351-4.
8. Ndugulile F, Jureen R, Harthug S, Urassa W, Langeland N. Extended spectrum beta-lactamases among gram-negative bacteria of nosocomial origin from an intensive care unit of a tertiary health facility in Tanzania. BMC Infect Dis. 2005;5:86.
9. Jadhav S, Gandham N, Paul R, Misra RN, Ujagare MT, Angadi K, *et al*. Bacteriological profile of septicaemia and antimicrobial susceptibility of isolates from tertiary care hospital in India. Res J Pharm Biol Chem Sci. 2012;3:1100-8.
10. Karunakaran R, Raja NS, Ng KP, Navaratnam P. Etiology of blood culture isolates among patients in a multidisciplinary teaching hospital in Kuala Lumpur. J Microbiol Immunol Infect. 2007;40:432-7.
11. Vasudeva N, Nirwan PS, Shrivastava P. Bloodstream infections and antimicrobial sensitivity patterns in a tertiary care hospital of India. Ther Adv Infect Dis. 2016;3:119-27.
12. Wattal C, Raveendran R, Goel N, Oberoi JK, Rao BK. Ecology of blood stream infection and antibiotic resistance in intensive care Unit at a tertiary care hospital in North India. Braz J Infect Dis. 2014;18:245-51.
13. Rajeevan S, Ahmed SM, Jasmin PT. Study of prevalence and antimicrobial susceptibility pattern in blood isolates from a tertiary care hospital in North Kerala, India. Int J Curr Microbiol Appl Sci. 2014;3:655-62.
14. Sharma R, Sharma R, Gupta S. Bacteriological analysis of blood culture isolates with their antibiogram from a tertiary care hospital. Int J Pharm Sci Res. 2015;6:4847-51.
15. Gupta S, Kashyap B. Bacteriological profile and antibiogram of blood culture isolates from a tertiary care hospital of North India. Trop J Med Res. 2016;19:94-9.
16. Tariq TM. Bacteriologic profile and antibiogram of blood culture isolates from a children's hospital in Kabul. J Coll Physicians Surg Pak. 2014;24:396-9.
17. Iregbu KC, Elegba OY, Babaniyi IB. Bacteriological profile of neonatal septicaemia in a tertiary hospital in Nigeria. Afr Health Sci. 2006;6:151-4.
18. Mehdinejad M, Khosravi AD, Morvaridi A. Study of prevalence and antimicrobial susceptibility pattern of bacteria isolated from blood cultures. J Biol Sci. 2009;9:249-53.
19. Sharma M, Goel N, Chaudhary U, Aggarwal R, Arora DR. Bacteraemia in children. Indian J Pediatr. 2002;69:1029-32.
20. Lee A, Mirrett S, Reller LB, Weinstein MP. Detection of bloodstream infections in adults: How many blood cultures are needed? J Clin Microbiol. 2007;45:3546-8.
21. Mangaraj J, Barkataki D. Microbiological profile of blood stream infection in neutropenic patient in a tertiary care centre. Int J Curr Microbiol App Sci. 2017;6(3):1137-45.
22. Tak H, Kanne P, Teja VD. Bloodstream infections in cardiac intensive care units from a tertiary care center. Indian J Microbiol Res. 2023;10(4):222-30.
23. Banik A, Bhat SH, Kumar A, Palit A, Snehaa K. Bloodstream infections and trends of antimicrobial sensitivity patterns at Port Blair. J Lab Physicians. 2018;10:332-7.