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Clinico-Microbiological Profile of Bloodstream Infections and Antibiotic Resistance Pattern in a Tertiary Care Hospital: an Observational Study.

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Abstract

Background: Bloodstream infections are clinically important because delayed microbiological diagnosis and resistant pathogens increase morbidity, antimicrobial exposure, and mortality. Local data are essential for selecting empirical therapy and strengthening antimicrobial stewardship. ***Objective:*** To describe the clinico-microbiological profile, probable source distribution, antimicrobial resistance pattern, and clinical outcome of bloodstream infections in a tertiary care hospital. ***Methods:*** This hospital-based observational study included 100 patients with culture-confirmed bloodstream infections at Maheshwara Medical College, Patancheru, Hyderabad, Telangana, India, from May 2024 to April 2025. Demographic details, clinical features, risk factors, probable source of infection, blood culture isolates, antimicrobial susceptibility profile, and outcome were analyzed using descriptive statistics. ***Results:*** The mean age was 42.6 +/- 19.8 years, and males constituted 58.0%. Prior antibiotic exposure was present in 52.0%, ICU admission in 38.0%, urinary catheterization in 31.0%, and central venous catheterization in 28.0%. Fever was the commonest presentation. Gram-negative bacteria accounted for 68.0% of isolates, followed by Gram-positive bacteria in 26.0% and Candida species in 6.0%. Klebsiella pneumoniae was the leading isolate, followed by Escherichia coli and Staphylococcus aureus. Among Gram-negative isolates, resistance was highest to ampicillin, third-generation cephalosporins, and ciprofloxacin. ESBL production and multidrug resistance were observed in 45.6% and 57.4%, respectively. Mortality was 19.0%. ***Conclusion:*** Bloodstream infections were predominantly caused by resistant Gram-negative bacteria. Routine blood culture surveillance, rational empirical antibiotic use, and infection-control measures are essential in tertiary care settings.

Keywords: Bloodstream infection; antimicrobial resistance; bacteremia; ESBL; multidrug resistance; Klebsiella pneumoniae; tertiary care hospital.

INTRODUCTION

Bloodstream infection (BSI) is a major clinical syndrome encountered in emergency departments, medical wards, surgical units, obstetric units, and intensive care units. It ranges from uncomplicated bacteremia to severe sepsis and septic shock. Population-based reviews have shown wide variation in BSI incidence according to age distribution, healthcare exposure, blood culture practices, and comorbidity burden [1]. The overall burden of BSI remains substantial because it contributes to prolonged hospitalization, higher antimicrobial consumption, organ dysfunction, and avoidable mortality [2].

Hospital-onset and healthcare-associated BSIs are particularly important in tertiary care hospitals, where patients frequently have invasive devices, underlying chronic illness, recent surgical procedures, intensive care admission, and prior antimicrobial exposure. Large surveillance studies have demonstrated that nosocomial BSI is associated with diverse bacterial and fungal pathogens and considerable crude mortality [3]. In critically ill patients, BSI also alters empirical antibiotic choices, source-control decisions, and the intensity of hemodynamic monitoring [4]. Clinical identification of sepsis has evolved over time, and current definitions emphasize life-threatening organ dysfunction resulting from a dysregulated host response to infection [5].

The microbiological spectrum of BSI differs across regions and hospital units. While Gram-positive organisms are commonly reported in some high-income settings, many Indian and other low- and middle-income tertiary care hospitals report a high burden of Gram-negative organisms, particularly Klebsiella pneumoniae, Escherichia coli, Acinetobacter species, and Pseudomonas aeruginosa. This variation underscores the need for local antibiogram-based decision-making rather than uniform empirical therapy.

Antimicrobial resistance (AMR) has become a major global health threat. Inappropriate antimicrobial use, delayed microbiological diagnosis, poor infection prevention practices, and transmission of resistant organisms within hospitals accelerate the emergence of multidrug-resistant pathogens [6]. Global burden estimates have identified bacterial AMR as a leading contributor to infection-related deaths, with resource-limited settings facing a disproportionate impact [7]. Recent Indian multicentric data have also shown rising resistance in bloodstream isolates, including increasing carbapenem resistance among important Gram-negative pathogens [8]. Similar Indian tertiary care studies have emphasized the dominance of resistant Gram-negative organisms in ICU and hospital settings [9,10]. Such hospital-level evidence is particularly useful where empirical treatment is initiated before culture confirmation and where stewardship teams require current, unit-specific resistance data for policy revision.

Considering the local relevance of BSI surveillance, the present study was undertaken with the objective of describing the demographic and clinical profile of patients with bloodstream infections, identifying the microbiological spectrum of blood culture isolates, assessing antibiotic resistance patterns including ESBL production and multidrug resistance, and documenting short-term clinical outcomes among patients treated at a tertiary care hospital.

MATERIALS AND METHODS

Study design and setting: This hospital-based observational study was conducted in the Departments of Microbiology and associated clinical departments at Maheshwara Medical College, Patancheru, Hyderabad, Telangana, India. The study was carried out over one year from May 2024 to April 2025. The study included patients admitted with clinical suspicion of bloodstream infection and subsequently confirmed by positive blood culture.

Study population and sample size: A total of 100 patients with bloodstream infections were included. Patients of either sex and all eligible age groups with a clinically significant positive blood culture were considered for analysis. Repeat isolates from the same patient during the same infective episode were excluded to avoid duplication. Cases with incomplete essential clinical or microbiological records were not included.

Data collection: Demographic variables, age, sex, admission unit, prior antibiotic exposure, intensive care unit admission, comorbidities, catheterization, central venous catheter use, mechanical ventilation, recent surgery or procedure, clinical presentation, probable source of infection, and outcome were recorded using a structured data collection form. The probable source of infection was assigned based on clinical diagnosis, relevant laboratory findings, imaging, and treating-unit documentation.

Blood culture and microbiological processing: Blood samples were collected under aseptic precautions before antibiotic administration whenever feasible. Culture bottles were processed in the microbiology laboratory according to standard institutional protocols. Positive cultures were subjected to Gram staining, subculture on appropriate media, and identification by conventional biochemical methods and/or available automated identification systems. Organisms considered contaminants on clinical and microbiological review were excluded.

Antimicrobial susceptibility testing: Antimicrobial susceptibility testing was performed by standard laboratory methods and interpreted using contemporary breakpoint principles for clinically relevant isolates [11]. Antibiotics tested were selected according to organism group and institutional laboratory policy. ESBL screening and confirmation were performed for relevant Gram-negative isolates. Multidrug resistance was defined as non-susceptibility to at least one agent in three or more antimicrobial categories, consistent with accepted international definitions [12].

Outcome assessment and statistical analysis: The primary microbiological outcomes were organism distribution and antibiotic resistance pattern. The clinical outcome was categorized as improved and discharged, referred or discharged against medical advice, or death. Data were entered and analyzed using descriptive statistics. Categorical variables were expressed as frequency and percentage. Continuous variables were expressed as mean with standard deviation. Laboratory quality assurance procedures, routine media checks, and internal controls were followed according to institutional microbiology practice. Clinically significant isolates were reviewed along with patient context to reduce misclassification of contaminants.

RESULTS

A total of 100 patients with bloodstream infections were included in the study. The mean age of the study population was 42.6 +/- 19.8 years. Most patients belonged to the 41-60 years age group. Males constituted 58.0% of the study population. Prior antibiotic exposure, ICU admission, urinary catheterization, and central venous catheterization were the common associated clinical risk factors, as shown in Table 1.

Table 1. Baseline demographic profile and clinical risk factors of the study population

Variable	Number of patients	Percentage
Total patients	100	100.0
Mean age	42.6 years	+/-19.8
Age group		
<20 years	14	14.0
21-40 years	28	28.0
41-60 years	36	36.0
>60 years	22	22.0
Sex		
Male	58	58.0
Female	42	42.0
Prior antibiotic exposure	52	52.0
ICU admission	38	38.0
Urinary catheterization	31	31.0
Central venous catheterization	28	28.0
Diabetes mellitus	26	26.0
Mechanical ventilation	19	19.0
Recent surgery/procedure	16	16.0

Fever was the most common clinical presentation, followed by chills or rigors and hypotension. Respiratory distress, altered sensorium, oliguria, and septic shock were also observed in a considerable proportion of patients. The most common probable source of bloodstream infection was respiratory tract infection, followed by urinary tract infection and intra-abdominal infection. Clinical presentation and probable source distribution are summarized in Table 2.

Table 2. Clinical presentation and probable source of bloodstream infection

Parameter	Number of patients	Percentage
Clinical presentation		
Fever	88	88.0
Chills/rigors	54	54.0
Localized infective focus	44	44.0
Hypotension	32	32.0
Respiratory distress	26	26.0
Altered sensorium	21	21.0
Oliguria	18	18.0
Septic shock	17	17.0
Probable source of infection		
Respiratory tract infection	24	24.0
Urinary tract infection	18	18.0
Intra-abdominal infection	14	14.0

Catheter-associated bloodstream infection	12	12.0
Skin and soft tissue infection	8	8.0
Obstetric/gynaecological source	6	6.0
Unknown primary focus	18	18.0

Gram-negative bacteria were the predominant bloodstream isolates, accounting for 68.0% of cases. Gram-positive bacteria constituted 26.0%, while Candida species were isolated in 6.0% of cases. Klebsiella pneumoniae was the most common isolate, followed by Escherichia coli, Staphylococcus aureus, Acinetobacter species, and coagulase-negative staphylococci. The microbiological profile is presented in Table 3.

Table 3. Microbiological profile of bloodstream isolates

Organism isolated	Number of isolates	Percentage
Gram-negative bacteria	68	68.0
Klebsiella pneumoniae	24	24.0
Escherichia coli	18	18.0
Acinetobacter species	10	10.0
Pseudomonas aeruginosa	8	8.0
Salmonella Typhi	4	4.0
Enterobacter species	4	4.0
Gram-positive bacteria	26	26.0
Staphylococcus aureus	12	12.0
Coagulase-negative staphylococci	8	8.0
Enterococcus species	6	6.0
Candida species	6	6.0
Total	100	100.0

Among Gram-negative isolates, maximum resistance was observed to ampicillin, third-generation cephalosporins, and ciprofloxacin. Carbapenem resistance was observed in 25.0% of Gram-negative isolates. ESBL-producing and multidrug-resistant Gram-negative isolates accounted for 45.6% and 57.4%, respectively. Among Gram-positive isolates, resistance was high to penicillin and erythromycin, while all Gram-positive isolates were susceptible to vancomycin and linezolid. Overall mortality was 19.0%. The antibiotic resistance pattern and clinical outcome are shown in Table 4.

Table 4. Antibiotic resistance pattern and clinical outcome

Parameter	Resistant isolates / patients	Percentage
Gram-negative isolates, n=68		
Ampicillin	58	85.3
Cefotaxime/ceftriaxone	46	67.6
Ceftazidime	42	61.8
Ciprofloxacin	40	58.8
Gentamicin	31	45.6
Piperacillin-tazobactam	28	41.2

Amikacin	24	35.3
Meropenem/imipenem	17	25.0
Colistin	3	4.4
ESBL-producing Gram-negative isolates	31	45.6
MDR Gram-negative isolates	39	57.4
Gram-positive isolates, n=26		
Penicillin	20	76.9
Erythromycin	14	53.8
Clindamycin	10	38.5
Cotrimoxazole	9	34.6
MRSA among S. aureus, n=12	5	41.7
High-level gentamicin resistance among Enterococcus, n=6	2	33.3
Vancomycin	0	0.0
Linezolid	0	0.0
Clinical outcome, n=100		
Improved and discharged	73	73.0
Referred/discharged against medical advice	8	8.0
Death	19	19.0

Overall, the study showed that bloodstream infections were predominantly caused by Gram-negative bacteria, particularly Klebsiella pneumoniae and Escherichia coli. A high level of resistance to third-generation cephalosporins and fluoroquinolones was observed. The presence of ESBL-producing and multidrug-resistant isolates highlights the need for continuous blood culture surveillance, rational empirical antibiotic therapy, and strict infection-control measures.

DISCUSSION

The present study evaluated the clinico-microbiological profile and antibiotic resistance pattern of 100 patients with bloodstream infections in a tertiary care hospital. The mean age was 42.6 years, and males were slightly predominant. Prior antibiotic exposure, ICU admission, urinary catheterization, central venous catheterization, diabetes mellitus, and mechanical ventilation were common risk factors. These findings are clinically relevant because invasive devices, broad-spectrum antibiotic use, and critical illness create a favorable environment for bloodstream invasion by hospital-adapted and resistant organisms.

Fever was the leading clinical presentation, followed by chills or rigors, localized infective focus, hypotension, and respiratory distress. Septic shock was observed in 17.0% of patients, indicating that a significant proportion presented with severe systemic involvement. Respiratory tract infection was the most common probable source, followed by urinary tract infection, intra-abdominal infection, and catheter-associated infection. This pattern reflects the mixed medical, surgical, critical care, and device-associated burden of bloodstream infections in tertiary care settings.

Gram-negative bacteria accounted for 68.0% of isolates, while Gram-positive bacteria and Candida species accounted for 26.0% and 6.0%, respectively. Klebsiella pneumoniae and Escherichia coli were the leading organisms. This predominance of Gram-negative pathogens is consistent with recent Indian multicentric surveillance and North Indian tertiary care data, where Enterobacterales and non-fermenters contributed substantially to BSI burden [8,9]. Datta et al. also documented a sustained burden of multidrug-resistant Escherichia coli and Klebsiella pneumoniae bloodstream infections in a tertiary care hospital, supporting the importance of local surveillance [10].

The resistance profile in the present study is a matter of concern. Gram-negative isolates showed high resistance to ampicillin, cefotaxime or ceftriaxone, ceftazidime, and ciprofloxacin. ESBL production was observed in 45.6% of Gram-negative isolates. ESBL enzymes hydrolyze expanded-spectrum cephalosporins and limit the utility of several beta-lactam antibiotics [13]. Carbapenem resistance was observed in 25.0% of Gram-negative isolates, which is worrisome because carbapenems are often used for severe infections caused by ESBL-producing organisms. The global spread of carbapenemase-producing Enterobacterales has restricted treatment choices and increased dependence on last-line agents [14].

Among Gram-positive isolates, penicillin and erythromycin resistance were common. MRSA constituted 41.7% of Staphylococcus aureus isolates, while vancomycin and linezolid resistance were not detected. Overall mortality was 19.0%, with deaths likely reflecting the combined influence of severe illness, delayed presentation, comorbidities, ICU care, and resistant pathogens. These findings support the need for rapid blood culture reporting, periodic antibiogram preparation, antimicrobial stewardship, central line care bundles, catheter review, infection-control audits, and early de-escalation once culture results become available.

Limitations

Bloodstream infections in this tertiary care hospital were predominantly caused by Gram-negative bacteria, with Klebsiella pneumoniae and Escherichia coli as leading isolates. High resistance to third-generation cephalosporins, fluoroquinolones, and a notable level of carbapenem resistance indicate a challenging therapeutic environment. ESBL-producing and multidrug-resistant isolates formed a substantial proportion of Gram-negative pathogens. Fever, prior antibiotic exposure, ICU admission, urinary catheterization, and central venous catheterization were frequent clinical associations. Regular blood culture surveillance, updated institutional antibiograms, timely organism identification, rational empirical antibiotic policies, and strict infection-control practices are essential to improve clinical outcomes and limit further spread of resistant bloodstream pathogens.

CONCLUSION

The findings of this systematic review demonstrate that damage control surgery and damage control resuscitation play a critical role in improving survival outcomes among severely injured trauma patients, particularly those presenting with hemorrhagic shock, coagulopathy, hypothermia, and hemodynamic instability. Early hemorrhage control, balanced transfusion strategies, permissive hypotension, and protocolized hemostatic resuscitation were consistently associated with reduced mortality, improved physiologic stabilization, and better overall trauma outcomes. Recent advances including massive transfusion protocols, whole blood resuscitation, thromboelastography-guided therapy, and REBOA have further enhanced modern trauma care practices.

Although damage control approaches are associated with complications such as abdominal compartment syndrome, sepsis, organ dysfunction, and prolonged intensive care stay, the overall benefits in critically unstable trauma patients outweigh the associated risks when applied appropriately. The review also highlights the growing importance of structured trauma systems and protocol-driven resuscitation pathways in improving outcomes, including in resource-limited settings. Further large-scale multicentric prospective studies and standardized treatment protocols are required to optimize patient selection, minimize complications, and improve long-term outcomes in trauma surgery.

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