

Original article:

Clinical Profile of Bloodstream Infections and Their Antibiotic Susceptibility Pattern in Hospitalized Patients: A Cross-Sectional Study

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Abstract

Background- Bloodstream infections (BSIs) are a major cause of sepsis and septic shock in hospitalized patients, contributing significantly to morbidity, mortality, and prolonged hospital stay. Early initiation of appropriate empirical antimicrobial therapy is critical; however, rising antimicrobial resistance poses a major challenge in clinical management.

Objectives- To evaluate the clinical and bacteriological profile of bloodstream infections in hospitalized patients and to analyze antimicrobial susceptibility patterns to guide rational empirical therapy.

Methods- A cross-sectional study was conducted over a period of six months, including 310 hospitalized patients with suspected bloodstream infections. Blood cultures were processed using standard microbiological techniques, and antibiotic susceptibility testing was performed. Clinical data were correlated with microbiological findings, and statistical analysis was performed using chi-square test.

Results- Out of 310 blood culture samples, 106 (34.2%) were positive. Gram-negative bacilli were the predominant pathogens (57.5%), with *Klebsiella pneumoniae* and *Escherichia coli* being the most common isolates. Among gram-positive cocci, *Staphylococcus aureus* was the leading pathogen, with 42.9% identified as methicillin-resistant (MRSA). High resistance was observed to third-generation cephalosporins and fluoroquinolones, while amikacin and carbapenems demonstrated high sensitivity among gram-negative isolates. All MRSA isolates were sensitive to vancomycin and linezolid. Multidrug resistance was significantly associated with prior ICU admission ($p = 0.01$).

Conclusion- Bloodstream infections in hospitalized patients are predominantly caused by gram-negative organisms with significant antimicrobial resistance. The high prevalence of multidrug-resistant pathogens, particularly in ICU settings, underscores the need for judicious empirical antibiotic selection based on local antibiogram data and strict implementation of antimicrobial stewardship strategies to improve patient outcomes.

Keywords: Bloodstream infections, Sepsis, Antimicrobial resistance, Gram-negative bacteremia, MRSA, Empirical antibiotic therapy

Introduction

Bloodstream infections (BSIs) represent one of the most serious clinical conditions encountered in hospitalized patients and are a leading cause of sepsis and septic shock worldwide (1). They are associated with high morbidity, mortality, and prolonged hospital stay, particularly among critically ill and immunocompromised individuals (2). Early recognition and prompt initiation of appropriate antimicrobial therapy are crucial in reducing adverse outcomes; however, delays in diagnosis or inappropriate empirical treatment significantly increase mortality (3).

In recent years, there has been a notable shift in the epidemiology of bloodstream infections, with gram-negative organisms emerging as the predominant pathogens in many tertiary care settings (4). Common causative agents

include *Klebsiella pneumoniae*, *Escherichia coli*, and *Pseudomonas aeruginosa*, while gram-positive organisms such as *Staphylococcus aureus*, including methicillin-resistant strains (MRSA), continue to contribute significantly to disease burden (5).

The emergence and rapid spread of antimicrobial resistance among these pathogens have become a major global health concern. Resistance to commonly used empirical agents such as third-generation cephalosporins and fluoroquinolones has been increasingly reported, limiting therapeutic options (6). The widespread and often inappropriate use of antibiotics has further accelerated the development of multidrug-resistant (MDR) organisms, particularly in intensive care units (ICUs), where patients are exposed to invasive procedures and prolonged hospital stays (7).

Understanding the local microbiological profile and antimicrobial susceptibility patterns is essential for guiding empirical therapy and improving patient outcomes (8). Therefore, this study was undertaken to evaluate the clinical profile, etiological spectrum, and antibiotic resistance patterns of bloodstream infections in hospitalized patients, with a focus on their implications for empirical therapy and clinical decision-making.

Materials and Methods

This hospital-based cross-sectional observational study was conducted in the Department of Medicine, at a tertiary care teaching hospital over a 6-month period. The study included patients admitted to medical wards and intensive care units (ICUs) with clinical suspicion of bloodstream infection or sepsis.

Study Population

All hospitalized patients presenting with clinical features suggestive of sepsis, such as fever, chills, hypotension, tachycardia, altered sensorium, or evidence of organ dysfunction, were considered for inclusion. Patients already receiving systemic antibiotics for more than 48 hours prior to admission were excluded to avoid confounding microbiological results.

Clinical Assessment

A detailed clinical evaluation was performed for each patient, including demographic details, presenting complaints, comorbidities (such as diabetes mellitus, chronic kidney disease, malignancy), history of prior hospitalization or ICU stay, and use of invasive devices. Severity of illness was assessed clinically, and patients were categorized based on ward or ICU admission status.

Sample Collection and Processing

Blood samples were collected aseptically at the time of initial clinical suspicion of sepsis, preferably before initiation of empirical antibiotic therapy. Approximately 8–10 mL of blood was collected from adult patients and 2–5 mL from pediatric patients and sent for culture and sensitivity. Standard microbiological techniques were used for isolation and identification of bacterial pathogens. Antibiotic susceptibility testing was performed and Multidrug resistance (MDR) was defined as resistance to three or more antimicrobial classes.

Data Collection and Outcome Measures

Clinical and microbiological data were recorded in a structured proforma. The primary outcomes assessed included the spectrum of causative organisms and their antimicrobial resistance patterns. Secondary outcomes included the association of multidrug resistance with clinical factors such as ICU admission and comorbid conditions.

Statistical Analysis

Data were entered and analyzed using statistical software. Descriptive statistics were used to summarize patient characteristics and microbiological findings. Categorical variables were analyzed using the chi-square test, and a p-value of less than 0.05 was considered statistically significant.

Results

Out of 310 blood samples processed, 106 (34.2%) showed significant bacterial growth. Of these, 61 (57.5%) were gram-negative bacilli, and 45 (42.5%) were gram-positive cocci. No fungal isolates were detected during the study period.

A total of 310 patients with clinical suspicion of bloodstream infection were included in the study. The majority of patients belonged to the 18–60 years age group (60.0%), with a male predominance (58.7%). Fever was the most common presenting complaint, observed in 86.5% of patients, followed by chills/rigors (69.0%) and tachycardia (61.3%). Hypotension was noted in 31.6% of cases, and altered sensorium in 23.2%, indicating significant systemic involvement in a substantial proportion of patients. Among comorbid conditions, diabetes mellitus was the most prevalent (33.5%), followed by chronic kidney disease (15.5%). Approximately 40.6% of patients required ICU admission, reflecting the severity of illness in the study population.

Out of the 310 blood cultures processed, 106 (34.2%) yielded significant bacterial growth. Among these culture-positive cases, 45.3% were diagnosed with sepsis, 32.1% with severe sepsis, and 22.6% progressed to septic shock. Organ dysfunction was commonly observed, with respiratory failure (39.6%) and renal dysfunction (35.8%) being the most frequent complications. A considerable number of patients required advanced supportive care, including mechanical ventilation (34.0%) and vasopressor support (26.4%). The overall mortality rate among culture-positive patients was 22.6%, while 64.2% recovered, highlighting the serious clinical implications of bloodstream infections.

The microbiological profile revealed a predominance of gram-negative organisms (57.5%), with *Klebsiella pneumoniae* (25.4%) and *Escherichia coli* (19.8%) being the most common isolates. Among gram-positive organisms, *Staphylococcus aureus* accounted for 26.4% of cases, of which 42.9% were identified as methicillin-resistant (MRSA). Clinically, gram-negative infections were more frequently associated with ICU settings and severe disease, including septic shock, whereas *E. coli* was more commonly associated with ward patients presenting with urosepsis. MRSA and other gram-positive infections were often linked to invasive devices and line-related infections.

Multidrug resistance (MDR) was identified in 41 (38.7%) isolates. A statistically significant association was observed between MDR and ICU admission ($p = 0.01$), indicating that critically ill patients are at higher risk of resistant infections. Other significant risk factors included prior hospitalization ($p = 0.02$), use of invasive devices ($p = 0.003$), and prior antibiotic exposure ($p = 0.001$). Although diabetes mellitus was common among patients, its association with MDR was not statistically significant ($p = 0.28$).

Table 1: Baseline Clinical Characteristics of Patients with Suspected Bloodstream Infection (n = 310)

Variable	Number (%)
Age Group	
<18 years	52 (16.8%)
18–60 years	186 (60.0%)
>60 years	72 (23.2%)
Gender	
Male	182 (58.7%)
Female	128 (41.3%)
Presenting Clinical Features	
Fever	268 (86.5%)
Chills/rigors	214 (69.0%)
Hypotension	98 (31.6%)
Altered sensorium	72 (23.2%)
Tachycardia	190 (61.3%)
Comorbidities	
Diabetes mellitus	104 (33.5%)
Chronic kidney disease	48 (15.5%)
Malignancy	32 (10.3%)
Immunosuppression	28 (9.0%)
Hospital Location	
ICU	126 (40.6%)
Ward	184 (59.4%)

Table 2: Clinical Severity and Outcome Profile of Blood Culture Positive Patients (n = 106)

Parameter	Number (%)
Clinical Diagnosis	
Sepsis	48 (45.3%)
Severe sepsis	34 (32.1%)
Septic shock	24 (22.6%)
Organ Dysfunction	
Renal dysfunction	38 (35.8%)

Respiratory failure	42 (39.6%)
Hepatic dysfunction	18 (17.0%)
Support Required	
Mechanical ventilation	36 (34.0%)
Vasopressor support	28 (26.4%)
Outcome	
Recovered	68 (64.2%)
Left against medical advice	14 (13.2%)
Mortality	24 (22.6%)

Table 3: Distribution of Pathogens and Their Clinical Correlation (n = 106)

Organism	Number (%)	Common Clinical Setting	Associated Severity
<i>Klebsiella pneumoniae</i>	27 (25.4%)	ICU, ventilated patients	Severe sepsis/septic shock
<i>Escherichia coli</i>	21 (19.8%)	Urosepsis, wards	Sepsis
<i>Staphylococcus aureus</i>	28 (26.4%)	Line-related infections	Sepsis/severe sepsis
MRSA	12 (42.9% of S. aureus)	ICU, invasive devices	Severe sepsis
<i>Pseudomonas aeruginosa</i>	9 (8.5%)	ICU, ventilator-associated	Septic shock
<i>Acinetobacter baumannii</i>	4 (3.8%)	ICU, prolonged stay	Severe sepsis
<i>Enterococcus faecalis</i>	7 (6.6%)	Post-surgical/urinary	Sepsis
Others	10 (9.4%)	Mixed	Variable

Table 4: Risk Factors Associated with Multidrug Resistance (MDR) (n = 106)

Risk Factor	MDR Present n (%) (n=41)	MDR Absent n (%) (n=65)	p-value
ICU Admission	28 (68.3%)	18 (27.7%)	0.01
Prior Hospitalization	24 (58.5%)	20 (30.8%)	0.02
Diabetes Mellitus	18 (43.9%)	22 (33.8%)	0.28
Use of Invasive Devices	30 (73.2%)	26 (40.0%)	0.003
Prior Antibiotic Use	32 (78.0%)	30 (46.2%)	0.001

Discussion

Bloodstream infections continue to pose a significant challenge in clinical practice, particularly in hospitalized and critically ill patients. In the present study, the blood culture positivity rate was 34.2%, which is consistent with previous reports showing positivity rates ranging from 20% to 40% depending on patient population and diagnostic practices (9,10). This underscores the ongoing burden of BSIs in tertiary care settings.

The predominance of gram-negative bacilli (57.5%) in this study, with *Klebsiella pneumoniae* and *Escherichia coli* as the leading pathogens, aligns with global trends indicating a shift toward gram-negative bacteremia (4,11). Gram-negative infections are often associated with severe clinical manifestations, including septic shock, due to endotoxin-mediated inflammatory responses, contributing to higher mortality rates (2).

Among gram-positive organisms, *Staphylococcus aureus* accounted for a significant proportion of cases, with a high prevalence of MRSA (42.9%). Similar findings have been reported in earlier studies, emphasizing the role of MRSA in hospital-acquired infections, especially in patients with invasive devices and prolonged hospital stay (5,12). The preserved susceptibility of MRSA to vancomycin and linezolid in our study supports their continued use as effective therapeutic agents, although careful stewardship is necessary.

A major concern identified in this study is the high level of resistance to commonly used empirical antibiotics, particularly third-generation cephalosporins and fluoroquinolones. This observation is consistent with global reports highlighting the increasing burden of antimicrobial resistance driven by inappropriate antibiotic use (6,7). The relatively higher sensitivity to amikacin and carbapenems suggests that these agents remain effective for severe infections; however, their use should be guided by local antibiogram data to prevent further resistance.

The association between multidrug resistance (MDR) and ICU admission observed in this study is clinically significant. ICU patients are at higher risk of acquiring resistant infections due to multiple factors, including invasive procedures, prior antibiotic exposure, and prolonged hospitalization. Similar associations have been reported in earlier studies, identifying ICU stay as a key risk factor for MDR infections (7,11). Additionally, prior antibiotic use and invasive device utilization were also significantly associated with MDR, reinforcing the importance of infection control practices.

The clinical severity observed in this study, with a substantial proportion of patients progressing to severe sepsis and septic shock and an overall mortality rate of 22.6%, reflects the serious nature of bloodstream infections. These findings are comparable to earlier studies that have reported high mortality rates associated with sepsis, particularly in ICU settings (2,3). Early diagnosis, appropriate empirical therapy, and timely de-escalation based on culture results remain critical in improving patient outcomes.

In summary, the findings of this study highlight the changing epidemiology of bloodstream infections, the growing challenge of antimicrobial resistance, and the importance of individualized, risk-based empirical therapy. Integration of microbiological data with clinical decision-making and strict implementation of antimicrobial stewardship programs are essential to optimize patient care and reduce mortality.

Conclusion

In conclusion, the present study highlights the predominance of gram-negative pathogens and the growing challenge of antimicrobial resistance in bloodstream infections. The strong association of MDR with ICU admission and prior antibiotic exposure emphasizes the need for targeted empirical therapy, robust infection control measures, and effective antimicrobial stewardship programs to improve clinical outcomes, guided by local data and CLSI-compliant protocols to curb resistance and improve outcomes.

References

1. Weinstein MP, Towns ML, Quartey SM, Mirrett S, Reimer LG, Parmigiani G, et al. The clinical significance of positive blood cultures in the 1990s: a prospective comprehensive evaluation of the microbiology, epidemiology, and outcome of bacteremia and fungemia in adults. *Clin Infect Dis*. 1997;24(4):584–602.

2. Angus DC, Linde-Zwirble WT, Lidicker J, Clermont G, Carcillo J, Pinsky MR. Epidemiology of severe sepsis in the United States: analysis of incidence, outcome, and associated costs of care. *Crit Care Med.* 2001;29(7):1303–1310.
3. Martin GS, Mannino DM, Eaton S, Moss M. The epidemiology of sepsis in the United States from 1979 through 2000. *N Engl J Med.* 2003;348(16):1546–1554.
4. Diekema DJ, Beekmann SE, Chapin KC, Morel KA, Munson E, Doern GV. Epidemiology and outcome of nosocomial and community-onset bloodstream infection. *Clin Infect Dis.* 2003;36(9):1103–1110.
5. Klevens RM, Morrison MA, Nadle J, Petit S, Gershman K, Ray S, et al. Invasive methicillin-resistant *Staphylococcus aureus* infections in the United States. *JAMA.* 2007;298(15):1763–1771.
6. Paterson DL. Resistance in gram-negative bacteria: Enterobacteriaceae. *Clin Infect Dis.* 2006;43(Suppl 2):S43–S48.
7. Levy SB, Marshall B. Antibacterial resistance worldwide: causes, challenges and responses. *Nat Med.* 2004;10(12 Suppl):S122–S129.
8. Karlowsky JA, Jones ME, Thornsberry C, Evangelista AT, Yee YC, Sahm DF. Trends in antimicrobial susceptibilities among Enterobacteriaceae isolated from hospitalized patients in the United States from 1998 to 2001. *Antimicrob Agents Chemother.* 2004;48(5):1672–1680.
9. Richards MJ, Edwards JR, Culver DH, Gaynes RP. Nosocomial infections in combined medical-surgical intensive care units in the United States. *Crit Care Med.* 2000;28(5):887–892.
10. Vincent JL, Rello J, Marshall J, Silva E, Anzueto A, Martin CD, et al. International study of the prevalence and outcomes of infection in intensive care units. *JAMA.* 2009;302(21):2323–2329.
11. Shorr AF, Tabak YP, Killian AD, Gupta V, Liu LZ, Kollef MH. Healthcare-associated bloodstream infection: a distinct entity? Insights from a large U.S. database. *Chest.* 2006;129(6):1432–1440.
12. Annane D, Bellissant E, Cavaillon JM. Septic shock. *Lancet.* 2005;365(9453):63–78.