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Original Research Article

Observational Study on the Occurrence, Microbiological Profile and Outcomes of Blood Culture–Positive Sepsis Patients at a Tertiary Care Hospital

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Abstract:

Background: Blood culture–positive sepsis is associated with significant morbidity and mortality. Understanding pathogen distribution and resistance patterns is essential for guiding empiric therapy and stewardship efforts.

Methods: This observational study was conducted at Apollo Hospital, Bhubaneswar, over 18 months, including 200 consecutive adult patients fulfilling Sepsis-3 criteria and yielding clinically significant organisms on blood culture. Demographic, clinical, microbiological and outcome data were recorded. Antimicrobial susceptibility testing followed CLSI guidelines. In-hospital mortality was the main outcome; duration of stay, ICU admission, and mechanical ventilation were the secondary outcomes.

Results: The median age was 56 years (IQR 44–67), with 62% males. Frequent sources of infection were respiratory (30%), urinary (22%) and intra-abdominal (18%). Gram-negative organisms predominated (60%), followed by Gram-positive bacteria (30%) and Candida species (10%). The most common pathogens were E. coli (25%), S. aureus (20%), K. pneumoniae (17.5%), Acinetobacter baumannii (10%) and P. aeruginosa (7.5%). MDR organisms accounted for 35% of isolates. ESBL production was detected in 40% of E. coli and 45.7% of K. pneumoniae. Carbapenem resistance was highest in Acinetobacter (70% MDR) and Klebsiella (20%). ICU admission occurred in 55% and mechanical ventilation in 40%. The median hospital stay was 12 days (IQR 8–16). Overall mortality was 30%. Higher SOFA scores, MDR infections and delayed appropriate antibiotics (>3 hours) were independently associated with mortality.

Conclusion: Gram-negative pathogens with substantial MDR prevalence predominated among culture-positive sepsis patients. Mortality remained high, driven by disease severity, antimicrobial resistance and delays in effective therapy. Early appropriate antibiotics and strengthened stewardship are essential to improve outcomes.

Keywords: ICU, IQR, MDR

Introduction

Sepsis continues to be a major clinical problem worldwide because of its rapid progression and high mortality, especially when the infection spreads to the bloodstream. The Sepsis-3 definition highlights the central role of organ dysfunction, emphasizing that timely recognition is critical [1].

Blood culture remains the most reliable tool to confirm a bloodstream infection, determine the pathogen and obtain susceptibility information needed to guide therapy[2]. Despite greater awareness and better critical care facilities, many patients still present late or receive initial therapy that is not tailored to local pathogen patterns [3]. In such situations, knowledge of hospital-specific microbiology becomes essential for deciding early empirical therapy and preventing further complications.

The growing challenge of antimicrobial resistance has added further complexity to sepsis management. Over the past decade, Indian hospitals have reported increasing resistance among common Gram-negative organisms such as E. coli, K. pneumoniae, Acinetobacter and Pseudomonas [4,5]. ESBL production, carbapenem resistance and multidrug resistance have become increasingly frequent, particularly in tertiary-care settings that receive seriously ill or previously treated patients [6,7].

Resistant Gram-positive pathogens like MRSA and the rising detection of Candida species also demand careful consideration [8,9]. These shifting microbiological trends often render standard empirical regimens inadequate, underscoring the need for updated local data to support rational antimicrobial decisions [10].

Outcomes in blood culture–positive sepsis depend not only on the infecting organism but also on patient factors such as age, coexisting illnesses, source of infection and baseline organ function [11,12]. High SOFA scores, delays in receiving appropriate antibiotics and infections caused by resistant organisms have consistently been linked with higher mortality. In many hospitals, a significant proportion of culture-positive sepsis cases originate from respiratory, urinary or intra-abdominal infections, each carrying a distinct risk profile [13,10]. Understanding these clinical patterns helps clinicians anticipate deterioration, initiate timely therapy and identify patients who may require early transfer to intensive care [14,15].

Apollo Hospital, Bhubaneswar, caters to patients from a wide geographic region and frequently handles severe infections referred from peripheral centres. The microbial spectrum and resistance patterns encountered here may differ from those reported elsewhere, making it important to generate centre-specific evidence.

At present, the region has limited published data describing the organisms involved in bloodstream infections, their susceptibility profiles and the outcomes of sepsis managed under contemporary criteria.

This study therefore aimed to document the occurrence, microbiological distribution and clinical outcomes of blood culture–positive sepsis patients treated at our hospital over an 18-month period. The findings are intended to support more informed empirical prescribing, guide stewardship efforts and assist in refining local treatment protocols.

Materials and Methods

Study design and setting

An observational study was conducted at Apollo Hospital, Bhubaneswar, from January 2024 to June 2025 (18 months). All eligible patients admitted across medical wards, ICUs and emergency services were evaluated.

Inclusion criteria

1. All adult patients (aged ≥18 yrs.)

2. Those who had given written informed consent

Exclusion criteria

1. Prior hospital admission (within 2 weeks) with positive blood culture

Data collection

Data were recorded on a structured proforma:

- Demographics, comorbidities, vital parameters
- SOFA score at recognition of sepsis
- Source of infection
- Laboratory parameters (WBC, creatinine, bilirubin, lactate)
- Blood culture results
- Time to first appropriate antibiotic
- ICU admission, ventilation and vasopressor use
- Length of stay and final outcome

Microbiological methods

An automated method was used to process blood cultures. Gram staining and subculturing were performed on positive samples. At the species level, organisms were identified.

Tests for antimicrobial susceptibility were conducted in accordance with CLSI recommendations. Non-susceptibility to at least one agent in at least three antimicrobial classes was characterized as MDR.

Outcomes

- **Primary outcome:** in-hospital mortality
- **Secondary outcomes:** ICU admission, mechanical ventilation, MDR prevalence, length of hospital stay

Statistical analysis

The mean ± SD or median (IQR) were used to summarize continuous variables. Frequencies and percentages were used to express categorical variables. Chi-square/Fisher's exact test or t-test/Mann–Whitney U test were used for between-group comparisons. Multivariable logistic regression was used to find independent predictors of mortality. The threshold for significance was fixed at $p<0.05$.

Results

Patient Characteristics

A total of 200 blood culture–positive sepsis patients were included in the analysis. The median age was 56 years (IQR 44–67), and males accounted for 62% of the cohort. Diabetes (43%), CKD (15%) and chronic lung disease (11%) were the most frequent comorbidities.

Respiratory infections were the leading source of sepsis (30%), followed by urinary (22%) and intra-abdominal infections (18%). The median SOFA score at recognition of sepsis was 7 (IQR 4–10), indicating predominantly moderate-to-severe illness at presentation.

Microbiological Findings

Gram-negative organisms formed the majority of isolates (60%), followed by Gram-positive bacteria (30%) and Candida species (10%).

Escherichia coli (25%) and Staphylococcus aureus (20%) were the most frequently identified pathogens. Among Enterobacterales, ESBL production was common, particularly in E. coli (40%) and K. pneumoniae (45.7%).

Carbapenem resistance was highest among Acinetobacter baumannii (70% MDR) and K. pneumoniae (20%). Overall, multidrug-resistant organisms accounted for 35% of isolates.

Table 1: Distribution of organisms isolated from blood cultures (N = 200)

Organism	Number of isolates (n)	Percentage (%)
Escherichia coli	50	25.0
Staphylococcus aureus	40	20.0
Klebsiella pneumoniae	35	17.5
Acinetobacter baumannii	20	10.0
Pseudomonas aeruginosa	15	7.5
Candida species	20	10.0
Total	**200**	**100**

Treatment and Clinical Course

Empirical carbapenem therapy was started in 40% of patients, while glycopeptide or linezolid therapy was used in 18%. A total of 72% received appropriate definitive therapy after more than 3 hours from sepsis recognition.

Source control procedures were performed in 67.5% of patients for whom they were indicated. Intensive care support was required in more than half of the cohort (55%), with 40% requiring mechanical ventilation and 45% needing vasopressors.

Outcomes

The median length of hospital stay was 12 days (IQR 8–16). Overall in-hospital mortality was 30% (60/200).

Patients who died had higher SOFA scores, more frequent MDR infections and greater delays in receiving appropriate antibiotic therapy.

Multivariable logistic regression identified three independent predictors of mortality:

- SOFA ≥8 (aOR 3.5; 95% CI 1.9–6.4)
- MDR infection (aOR 2.1; 95% CI 1.2–3.8)
- Delay >3 hours to appropriate antibiotic (aOR 2.6; 95% CI 1.4–4.7)

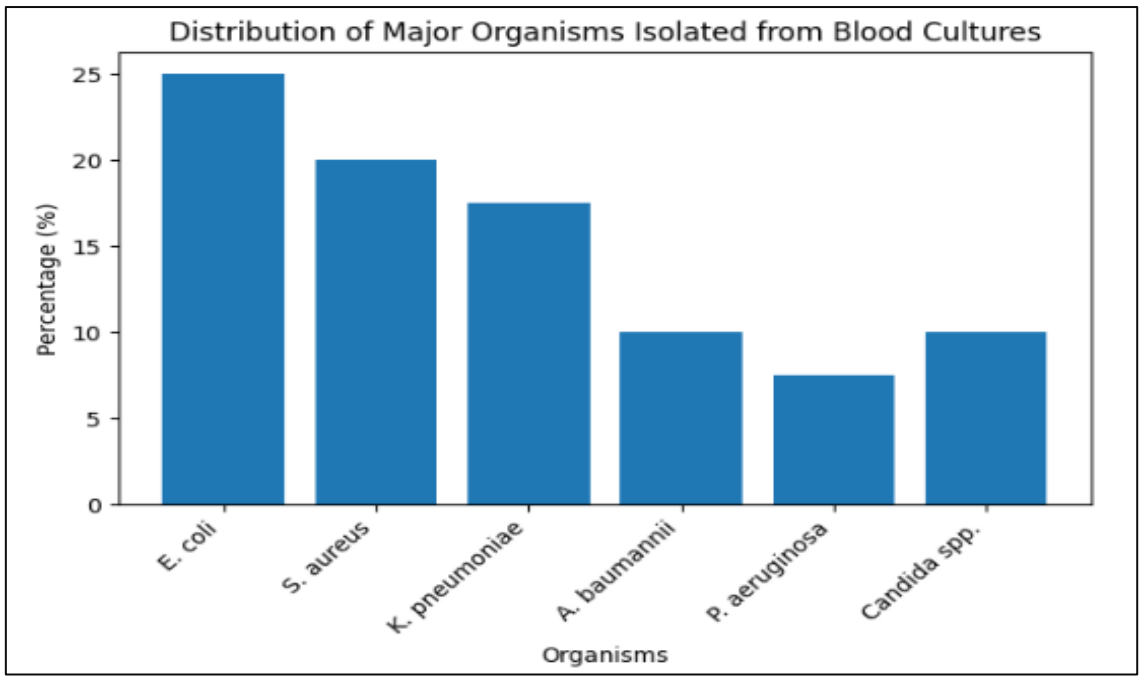

Figure 1: Distribution of major organisms isolated from blood cultures.

Table 2: Baseline Characteristics and Key Outcomes of the Study Population (N = 200)

Variable	Value
Age (median, IQR)	56 (44–67)
Male, n (%)	124 (62%)
Diabetes, n (%)	86 (43%)
CKD, n (%)	30 (15%)
SOFA score (median, IQR)	7 (4–10)
Source of infection – Respiratory	60 (30%)
Source – Urinary	44 (22%)
Source – Intra-abdominal	36 (18%)
MDR isolates, n (%)	70 (35%)
ICU admission, n (%)	110 (55%)
Mechanical ventilation, n (%)	80 (40%)
In-hospital mortality, n (%)	60 (30%)

Discussion

This study provides a comprehensive overview of blood culture–positive sepsis in a tertiary care setting and highlights the significant burden of severe infections encountered in everyday clinical practice. The predominance of middle-aged and elderly adults, along with a high prevalence of comorbidities such as diabetes and chronic kidney disease, reflects the typical population at risk for sepsis in Indian hospitals [11,12]. The majority of patients presented with moderate to severe organ dysfunction as indicated by their SOFA scores, emphasizing the need for early recognition and rapid management [1,13]. These observations are consistent with global data showing that patients with advanced physiological compromise at presentation have substantially poorer outcomes.

Gram-negative organisms were the leading cause of bloodstream infections in this cohort, which aligns with trends seen across many Indian tertiary centres. E. coli and Klebsiella pneumoniae were the most frequently isolated pathogens, followed by non-fermenters such as Acinetobacter baumannii and Pseudomonas aeruginosa [11,12]. This distribution corresponds well with the major sources of infection identified—respiratory, urinary and intra-abdominal infections—which commonly involve these bacteria. The significant presence of non-fermenters, particularly Acinetobacter, underscores the complexity of infections in critically ill patients and the challenges associated with their management in ICUs [15,14].

The resistance patterns observed in this study highlight the persistent challenge posed by antimicrobial resistance. ESBL production was common among E. coli and Klebsiella isolates, indicating the declining utility of third-generation cephalosporins for empirical therapy. Carbapenem resistance in Klebsiella and Acinetobacter further restricts available therapeutic options and increases reliance on last-resort agents [4-8]. These findings mirror national and international surveillance reports showing rising resistance among Gram-negative organisms, particularly in healthcare-associated infections. The detection of MRSA and VRE, although less common than Gram-negative resistance, also reinforces the need for continued vigilance against resistant Gram-positive pathogens [10,16].

Fungal bloodstream infections accounted for 10% of cases in this cohort, reflecting the growing importance of Candida species in critical care environments. Increasing use of broad-spectrum antibiotics, prolonged hospital stay and invasive medical devices likely contribute to the rising incidence of candidemia. Although not the dominant cause of sepsis, fungal

infections are associated with high mortality, making early identification and initiation of antifungal therapy essential. The detection of this proportion of Candida infections suggests that clinicians should maintain a high index of suspicion for fungal sepsis, especially in high-risk individuals [9,17].

Clinical outcomes in this study highlight the severity of illness in blood culture–positive sepsis. More than half of the patients required ICU care, 40% required mechanical ventilation and nearly half required vasopressor support. The overall mortality rate of 30% underscores the seriousness of bloodstream infections, particularly when associated with organ dysfunction and resistant pathogens. The mortality observed in this study is comparable to findings from other tertiary care hospitals in India and internationally. These similar outcomes reinforce the importance of effective sepsis recognition pathways and robust treatment protocols to improve survival [11,12,15].

A key finding of this analysis was the identification of SOFA score ≥8, MDR infection and delays exceeding three hours in initiating appropriate antibiotic therapy as independent predictors of mortality. These observations are consistent with well-established evidence that severity of organ dysfunction, pathogen resistance and timely initiation of effective therapy significantly influence outcomes.

The association between treatment delay and mortality in this cohort reinforces the urgency of prompt empirical therapy, rapid clinical evaluation and timely microbiological workup. In addition, infections caused by MDR organisms likely lead to delays in therapeutic optimization due to limited treatment options and initial empiric regimens failing to cover resistant pathogens [10,13,16].

The findings of this study emphasize the need for continuous monitoring of local microbiological trends, timely dissemination of antibiograms and strong antimicrobial stewardship interventions. Implementing rapid diagnostic workflows, optimizing blood culture collection practices and ensuring early escalation of care for high-risk patients may further reduce mortality. Although limited by its single-centre design, the study provides valuable insight into the epidemiology and outcomes of bloodstream infections in a major tertiary hospital in Eastern India. The results support the need for ongoing surveillance, multidisciplinary management of sepsis and evidence-based modification of empirical antibiotic policies to address regional resistance patterns and improve patient outcomes.

Conclusion

Blood culture–positive sepsis at our tertiary-care centre was predominantly caused by Gram-negative organisms, with a significant prevalence of MDR pathogens. Mortality remained high and was strongly influenced by disease severity, antimicrobial resistance and delays in effective therapy. Strengthening empiric therapy protocols, minimizing time to appropriate treatment and enhancing stewardship initiatives are crucial for improving outcomes in sepsis patients.

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