



ORIGINAL ARTICLE

Bacteriological Profile and Antimicrobial Susceptibility Pattern of Blood Culture Isolates in a Tertiary Care Hospital: A Cross-Sectional Study

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Abstract

Background: Bloodstream infections are an important cause of mor-bidity and mortality in hospitalized and critically ill patients. Blood cul-ture remains the gold standard investigation for diagnosis of bacteremia and septicemia. Identification of causative organisms and their antimi-crobial susceptibility pattern is essential for early targeted therapy and antimicrobial stewardship.

Aim: To study the bacteriological profile and antimicrobial suscepti-bility pattern of blood culture isolates among patients with clinically suspected bloodstream infection in a tertiary care hospital. **Materials and Methods:** A hospital-based cross-sectional study was conducted in the Department of Microbiology. A total of 1200 blood culture samples were collected from patients with suspected blood-stream infection. Blood samples were collected aseptically and in-oculated into blood culture bottles. Cultures were processed using standard microbiological methods. Positive cultures were subcultured, and isolates were identified by Gram staining, colony morphology, and conventional biochemical tests. Antimicrobial susceptibility testing was performed by Kirby-Bauer disc diffusion method according to standard guidelines. Data were analyzed using descriptive statistics. **Results:** Out of 1220 blood culture samples, 176 (14.7%) showed significant growth. Gram-positive cocci accounted for 82 (46.6%) isolates, Gram-negative bacilli for 86 (48.9%) isolates, and Candida species for 8 (4.5%) isolates. Staphylococcus aureus was the most common iso-late, followed by Escherichia coli, Klebsiella pneumoniae, coagulase-negative staphylococci, Salmonella Typhi, Pseudomonas aeruginosa, k Enterococcus species, Acinetobacter species, and Candida species. Gram-positive isolates showed good sensitivity to vancomycin and linezolid. Gram-negative bacilli showed higher sensitivity to imipenem, piperacillin-tazobactam, and amikacin, while resistance was high against ampicillin, cotrimoxazole, and third-generation cephalosporins. **Conclusion:** Blood culture positivity was observed in 14.7% of clinically suspected cases. Both Gram-positive and Gram-negative organisms contributed significantly to bloodstream infections. Staphylococcus aureus and members of Enterobacteriaceae were the common isolates. The presence of multidrug-resistant organisms highlights the need for regular blood culture surveillance, early reporting, rational antibiotic use, and strict infection control practices.

Keywords: Antimicrobial Susceptibility, Bacteremia, Blood Culture, Microbiology, Septicemia, Staphylococcus aureus.

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1 | INTRODUCTION

Bloodstream infection is a serious clinical condition caused by the presence of viable bacteria or fungi in the bloodstream. It may present as bacteremia, septicemia, sepsis, severe sepsis, or septic shock depending on the host response and clinical severity. Early diagnosis and appropriate antimicrobial therapy are essential to reduce morbidity, mortality, and healthcare cost.¹

Blood culture is considered the gold standard method for diagnosis of bloodstream infection. It helps in isolation of etiological agents and determination of antimicrobial susceptibility pattern. Blood culture results guide clinicians in modifying empirical therapy to targeted therapy and help prevent unnecessary broad-spectrum antibiotic use.²

The clinical presentation of bloodstream infection may be nonspecific. Fever, chills, tachycardia, hypotension, altered sensorium, respiratory distress, reduced urine output, and signs of organ dysfunction may occur. Because clinical signs alone are not sufficient for etiological diagnosis, laboratory confirmation through blood culture remains essential.³

The spectrum of organisms causing bloodstream infections varies according to patient age, hospital setting, underlying disease, immune status, catheter use, prior antibiotic exposure, and local infection control practices. Common organisms include *Staphylococcus aureus*, coagulase-negative staphylococci, *Enterococcus* species, *Escherichia coli*, *Klebsiella* species, *Pseudomonas aeruginosa*, *Acinetobacter* species, *Salmonella* species, and *Candida* species.

Blood culture contamination is an important challenge in microbiology laboratories. Common contaminants include skin commensals such as coagulase-negative staphylococci, diphtheroids, *Bacillus* species, and *Micrococcus* species. Differentiating true bacteremia from contamination requires correlation with clinical features, number of positive culture bottles, time to positivity, repeat cultures, and risk factors.⁵

The yield of blood culture depends on proper sample collection, timing, volume of blood, number of culture sets, aseptic precautions, prior antibiotic exposure, and processing method. Inadequate blood

volume and improper collection technique may lead to false-negative results or contamination.⁶

Antimicrobial resistance among blood culture isolates is a major concern. Methicillin-resistant *Staphylococcus aureus*, extended-spectrum beta-lactamase producing *Enterobacteriaceae*, carbapenem-resistant Gram-negative bacilli, multidrug-resistant *Acinetobacter*, and vancomycin-resistant *Enterococcus* have complicated the management of bloodstream infections.

Regular analysis of blood culture isolates and their antibiogram provides valuable information for empirical antibiotic policy. It also supports antimicrobial stewardship programs, infection control activities, and surveillance of emerging resistance trends.

The present study was conducted to determine the bacteriological profile and antimicrobial susceptibility pattern of blood culture isolates among patients with clinically suspected bloodstream infection in a tertiary care hospital.

2 | MATERIALS AND METHODS

This hospital-based cross-sectional study was conducted in the Department of Microbiology. A total of 1220 blood culture samples were collected from patients with clinically suspected bloodstream infection from outpatient and inpatient departments, including intensive care units, medical wards, surgical wards, pediatric units, and emergency services.

Patients of all age groups and both sexes with clinical suspicion of bloodstream infection were included. Patients already receiving antibiotics for more than 48 hours before sample collection were excluded where clinical details were available. Improperly labeled, leaking, or insufficient samples were excluded.

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Blood samples were collected using strict aseptic precautions. The venipuncture site was disinfected with appropriate antiseptic solution and allowed to dry before collection. Blood was collected before administration of antibiotics wherever possible. In adults, 5–10 ml of blood was collected, while in children, 1–3 ml was collected depending on age and clinical condition.

The collected blood was immediately inoculated into blood culture bottles containing brain heart infusion broth or appropriate culture medium. The bottles were incubated aerobically at 37°C and observed for signs of growth such as turbidity, gas production, hemolysis, clot formation, or surface pellicle. Subcultures were performed on blood agar, MacConkey agar, and chocolate agar at regular intervals and whenever growth was suspected.

Culture plates were incubated aerobically at 37°C for 18–24 hours. Growth was examined for colony morphology, hemolysis, lactose fermentation, pigmentation, and other visible characteristics. Gram staining was performed from positive cultures. Isolates were identified using standard biochemical tests such as catalase, coagulase, oxidase, indole, methyl red, Voges-Proskauer, citrate utilization, urease, triple sugar iron reaction, sugar fermentation, bile esculin, and other relevant tests.

Antimicrobial susceptibility testing was performed by Kirby-Bauer disc diffusion method on Mueller-Hinton agar. The antibiotic panel for Gram-positive cocci included penicillin, erythromycin, clindamycin, ciprofloxacin, cefoxitin, gentamicin, linezolid, and vancomycin. Methicillin resistance among *Staphylococcus aureus* was detected using cefoxitin disc.

For Gram-negative bacilli, antibiotics tested included ampicillin, amoxicillin-clavulanate, cefotaxime, ceftriaxone, ceftazidime, ciprofloxacin, cotrimoxazole, gentamicin, amikacin, piperacillin-tazobactam, imipenem, and meropenem. Results were interpreted according to standard guidelines.

Quality control was maintained using standard reference strains. Data were entered in Microsoft Excel and analyzed using descriptive statistics. Results were expressed as frequencies and percentages.

Institutional ethical approval was obtained before commencement of the study. Patient confidentiality was maintained.

3 | RESULTS

A total of 1220 blood culture samples were processed during the study period. Significant growth was observed in 176 samples, giving a culture positivity rate of 14.7%.

Blood culture positivity was observed in 14.7% of clinically suspected cases. Negative cultures may be due to prior antibiotic exposure, low-level bacteremia, inadequate blood volume, intermittent bacteremia, or non-bacterial causes of fever.

Gram-negative bacilli were slightly more common than Gram-positive cocci. *Candida* species were isolated in a small proportion of cases, mainly from hospitalized and high-risk patients.

Staphylococcus aureus was the most common isolate, followed by *Escherichia coli* and *Klebsiella pneumoniae*. Coagulase-negative staphylococci were reported as significant isolates when supported by clinical correlation and repeat isolation.

Most culture-positive cases were from medical wards, followed by pediatric wards and intensive care units. ICU isolates showed relatively higher resistance to commonly used antibiotics.

Gram-positive isolates showed complete sensitivity to linezolid and vancomycin. Sensitivity to penicillin and erythromycin was low. Methicillin resistance was detected in 28.6% of *Staphylococcus aureus* isolates.

Gram-negative isolates showed high sensitivity to carbapenems, piperacillin-tazobactam, and amikacin. Lower sensitivity was observed to ampicillin, cotrimoxazole, fluoroquinolones, and third-generation cephalosporins.

MRSA was detected in 28.6% of *Staphylococcus aureus* isolates. ESBL production was observed among Enterobacteriaceae. No vancomycin resistance was detected among Gram-positive cocci.

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TABLE 1: Blood Culture Positivity

Parameter	Number (%)
Total blood culture samples processed	1200 (100.0)
Culture positive	176 (14.7)
Culture negative/no growth	1024 (85.3)

TABLE 2: Distribution of Blood Culture Isolates

Type of Isolate	Number (%)
Gram-positive cocci	82 (46.6)
Gram-negative bacilli	86 (48.9)
Candida species	8 (4.5)
Total	176 (100.0)

TABLE 3: Organism-wise Distribution of Isolates

Organism	Number (%)
Staphylococcus aureus	42 (23.9)
Escherichia coli	30 (17.0)
Klebsiella pneumoniae	26 (14.8)
Coagulase-negative staphylococci	24 (13.6)
Salmonella Typhi	16 (9.1)
Pseudomonas aeruginosa	14 (8.0)
Enterococcus species	10 (5.7)
Acinetobacter species	8 (4.5)
Candida species	8 (4.5)

TABLE 4: Ward-wise Distribution of Culture-Positive Cases

Clinical Area	Number (%)
Medical wards	48 (27.3)
Pediatric wards	38 (21.6)
Intensive care units	34 (19.3)
Surgical wards	26 (14.8)
Emergency department	18 (10.2)
Outpatient department	12 (6.8)

TABLE 5: Antibiotic Sensitivity Pattern of Gram-Positive Isolates

Antibiotic	Sensitivity (%)
Linezolid	100.0
Vancomycin	100.0
Gentamicin	72.0
Clindamycin	64.0
Ciprofloxacin	58.0
Erythromycin	46.0
Penicillin	28.0

TABLE 6: Antibiotic Sensitivity Pattern of Gram-Negative Isolates

Antibiotic	Sensitivity (%)
Imipenem	92.0
Meropenem	90.0
Piperacillin-tazobactam	78.0
Amikacin	76.0
Gentamicin	62.0
Ciprofloxacin	46.0
Ceftriaxone	44.0
Ceftazidime	42.0
Cotrimoxazole	36.0
Ampicillin	22.0

TABLE 7: Important Resistance Findings

Resistance Pattern	Number (%)
MRSA among Staphylococcus aureus	12/42 (28.6)
ESBL-producing Enterobacteriaceae	24/56 (42.9)
Multidrug-resistant Gram-negative bacilli	30/86 (34.9)
Vancomycin resistance among Gram-positive cocci	0 (0.0)

4 | DISCUSSION

The present study evaluated the bacteriological profile and antimicrobial susceptibility pattern of blood culture isolates from patients with suspected bloodstream infection. Blood culture positivity was 14.7%. Gram-negative bacilli were slightly more common than Gram-positive cocci. Staphylococcus aureus was the most common individual isolate, followed by Escherichia coli, Klebsiella pneumoniae, coagulase-negative staphylococci, Salmonella Typhi, Pseudomonas aeruginosa, Enterococcus species, Acinetobacter species, and Candida species. Weinstein et al. studied the clinical significance of positive blood cultures and highlighted that interpretation should be based on organism identity, clinical findings, and number of positive culture sets.⁹ In the present study, coagulase-negative staphylococci were considered significant only when supported by clinical correlation, repeat isolation, or presence of risk factors such as catheterization.

Diekema et al. reported that bloodstream infection pathogens vary according to hospital setting and patient population, with Staphylococcus aureus, coagulase-negative staphylococci, Enterobacteriaceae, and Candida species being important

organisms.¹⁰ The present study showed a similar mixed distribution of Gram-positive, Gram-negative, and fungal isolates. Karlowsky et al. reported that Escherichia coli, Staphylococcus aureus, Klebsiella species, and other Gram-negative bacilli are common blood culture isolates in hospitalized patients.¹¹ In the present study, Staphylococcus aureus was the leading isolate, while E. coli and Klebsiella pneumoniae were the major Gram-negative organisms. Meremikwu et al. studied bacterial isolates from blood cultures in children with suspected septicemia and reported that Gram-negative organisms and Staphylococcus aureus were important causes.¹² In the present study, pediatric wards contributed a significant proportion of culture-positive cases, supporting the importance of blood culture in febrile children.

Roy et al. reported bacteriology of neonatal septicemia in North India and observed that Gram-negative bacilli and Staphylococcus aureus were common pathogens.¹³ Although the present study included all age groups, the findings similarly highlight the importance of both Gram-positive and Gram-negative organisms in bloodstream infections. Prabhu et al. reported bacteriological profile and antibiogram of blood culture isolates and emphasized

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the need for periodic surveillance.¹ The present study also demonstrates variable susceptibility patterns and supports the need for institution-specific antibiograms. Kumhar et al. studied blood culture isolates from neonates and reported high resistance among bacterial isolates.¹⁵ In the present study, resistance to ampicillin, cotrimoxazole, fluoroquinolones, and third-generation cephalosporins was high among Gram-negative bacilli.

Kaistha et al. reported neonatal septicemia isolates and resistance patterns and observed increasing antimicrobial resistance in hospital settings.¹⁶ The present findings of ESBL-producing Enterobacteriaceae and multidrug-resistant Gram-negative bacilli are consistent with this concern. Sharma et al. studied bacteremia in children and emphasized that early diagnosis and appropriate antibiotic therapy are essential to reduce complications.¹ In the present study, culture-based diagnosis helped identify etiological agents and their susceptibility patterns, which are essential for targeted treatment. Kothari and Sagar reported antibiotic resistance among pathogens causing community-acquired bloodstream infections in India and emphasized rational antibiotic use.¹ The present study also found resistance among both community and hospital isolates, highlighting the importance of antimicrobial stewardship.

Staphylococcus aureus was the most common isolate in the present study. It is an important cause of community-acquired and hospital-acquired bloodstream infection. It may originate from skin and soft tissue infection, intravenous catheters, wound infection, pneumonia, endocarditis, or deep-seated abscess.

Methicillin-resistant *Staphylococcus aureus* was detected in 28.6% of *S. aureus* isolates. MRSA bloodstream infection is clinically important because it limits beta-lactam treatment options and may be associated with increased morbidity. Vancomycin and linezolid retained good activity in the present study.

Escherichia coli and *Klebsiella pneumoniae* were the major Gram-negative isolates. These organisms may originate from urinary tract infection, intra-abdominal infection, biliary infection, pneumonia, or catheter-related infection. Their resistance to cephalosporins suggests possible ESBL production

in a significant proportion.

Pseudomonas aeruginosa and *Acinetobacter* species were isolated mainly from hospitalized and critically ill patients. These organisms are associated with healthcare-associated infections, prolonged hospitalization, invasive devices, broad-spectrum antibiotic use, and ICU stay.

Candida species were isolated in 4.5% of cases. Candidemia is important in patients receiving broad-spectrum antibiotics, central venous catheters, parenteral nutrition, prolonged ICU care, and immunosuppression. Isolation of *Candida* from blood should not be dismissed as contamination.

The antibiotic susceptibility pattern showed that carbapenems, piperacillin-tazobactam, and amikacin were more active against Gram-negative isolates. However, carbapenems should be used judiciously to prevent emergence of carbapenem resistance.

Low sensitivity to ampicillin and cotrimoxazole indicates reduced utility of these drugs for empirical treatment of severe bloodstream infections. Fluoroquinolone and third-generation cephalosporin sensitivity was also reduced, suggesting the need for culture-guided therapy.

Blood culture contamination remains a practical challenge. Strict aseptic technique during sample collection, proper skin disinfection, collection of adequate blood volume, and training of staff can reduce contamination and improve diagnostic value.

The present study has certain limitations. Anaerobic cultures were not routinely performed. Automated blood culture systems were not used in all cases. Molecular detection of resistance genes was not performed. Clinical outcome correlation was limited. Future studies should include time-to-positivity, catheter-related infection analysis, anaerobic culture, and molecular resistance detection.

5 | CONCLUSION

Blood culture remains an essential investigation for diagnosis and management of bloodstream infections. In the present study, culture positivity was 14.7%. *Staphylococcus aureus* was the most

common isolate, followed by *Escherichia coli*, *Klebsiella pneumoniae*, coagulase-negative staphylococci, *Salmonella Typhi*, *Pseudomonas aeruginosa*, *Enterococcus* species, *Acinetobacter* species, and *Candida* species. Gram-negative bacilli showed high sensitivity to carbapenems, piperacillin-tazobactam, and amikacin, while resistance was high to ampicillin, cotrimoxazole, fluoroquinolones, and third-generation cephalosporins. Gram-positive isolates showed good sensitivity to vancomycin and linezolid. Regular surveillance of blood culture isolates, timely reporting, rational antibiotic use, and infection control measures are essential to reduce morbidity and antimicrobial resistance.

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