

# Comparative Analysis of Gram-Positive and Gram-Negative Bacteria Isolated From Blood Samples and Their Antimicrobial Susceptibility Patterns

Kumari Arushi<sup>1</sup>, Dr. Malika Pal<sup>2</sup>, Ms. Anjali Kumari<sup>3</sup>

<sup>1</sup>Student, Department of Microbiology, Faculty of Science, SAM Global University, Raisen, Madhya Pradesh, India

<sup>2</sup>Professor, Department of Microbiology, Faculty of Science, SAM Global University, Raisen, Madhya Pradesh, India

<sup>3</sup>Assistant Professor, Department of Microbiology, Faculty of Science, SAM Global University, Raisen, Madhya Pradesh, India

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## ABSTRACT

Bloodstream infections (BSIs) are major causes of morbidity and mortality worldwide and require rapid diagnosis and appropriate antimicrobial therapy. The present study aimed to isolate, identify, and compare Gram positive and Gram negative bacteria from blood samples collected from patients suspected of septicemia. A total of 100 blood samples were processed using standard microbiological methods including blood culture, Gram staining, biochemical characterization, and antibiotic susceptibility testing. Seventy-two samples showed bacterial growth. Gram negative bacteria (58.33%) were more prevalent than Gram positive bacteria (41.67%). *Escherichia coli* and *Staphylococcus aureus* were the predominant isolates. High antimicrobial resistance was observed, including MRSA and ESBL-producing organisms. The findings highlight the growing challenge of antimicrobial resistance among bloodstream pathogens and emphasize the importance of continuous surveillance and rational antibiotic use.

**Keywords:** Bloodstream infections, Gram positive bacteria, Gram negative bacteria, Septicemia, Antimicrobial resistance

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## INTRODUCTION

Bloodstream infections (BSIs) represent one of the most serious infectious conditions encountered in clinical practice and are associated with significant morbidity, mortality, prolonged hospitalization, and increased healthcare costs. These infections occur when pathogenic microorganisms gain access to the bloodstream and disseminate throughout the body, potentially leading to septicemia, septic shock, and multiple organ dysfunction syndrome. Early diagnosis and prompt treatment are essential to improve patient outcomes.

Both Gram positive and Gram negative bacteria are important etiological agents of bloodstream infections. Gram positive organisms such as *Staphylococcus aureus*, coagulase-negative staphylococci, and *Enterococcus* species are frequently implicated in hospital-acquired infections and catheter-associated bacteremia. Gram negative pathogens including *Escherichia coli*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* are increasingly recognized as major causes of severe septicemia, particularly among hospitalized and immunocompromised patients.

The emergence of multidrug-resistant organisms has complicated the management of bloodstream infections. Methicillin-resistant *Staphylococcus aureus* (MRSA), extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae, and carbapenem-resistant organisms pose significant therapeutic challenges. Comparative studies evaluating Gram positive and Gram negative bacteria isolated from blood samples are therefore essential for understanding local epidemiological trends, guiding empirical therapy, and improving infection control strategies.

## MATERIALS AND METHODS

The present study was designed as a hospital-based observational and comparative microbiological investigation conducted in the Department of Microbiology, School of Sciences, SAM Global University, Raisen, Madhya Pradesh. The study was carried out over a period of five months from January 2026 to May 2026. Blood samples were collected from patients clinically suspected of bloodstream infections and septicemia.

A total of 100 blood samples were collected under aseptic conditions and inoculated into blood culture media. Positive cultures were subcultured on Blood Agar, MacConkey Agar, and Chocolate Agar for isolation of bacterial colonies. Preliminary identification was performed using Gram staining, followed by biochemical characterization through catalase, coagulase, oxidase, indole, citrate utilization, urease, and Triple Sugar Iron (TSI) tests.

Antimicrobial susceptibility testing was performed using the Kirby–Bauer disc diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines. Antibiotics tested against Gram positive bacteria included penicillin, erythromycin, ciprofloxacin, ceftazidime, vancomycin, and linezolid. Gram negative isolates were tested against cefotaxime, ceftazidime, ciprofloxacin, gentamicin, imipenem, and meropenem. MRSA was detected using ceftazidime disc diffusion, while ESBL-producing strains were identified by combination disc methods. Data were analyzed using percentage distribution and comparative statistical evaluation.

## RESULTS AND DISCUSSION

### 3.1 Blood Culture Positivity

A total of 100 blood samples were processed during the study period. Among these, 72 samples showed bacterial growth, resulting in a culture positivity rate of 72%, while 28 samples were culture negative.

**Table 1. Blood Culture Positivity**

Result	Number	Percentage (%)
Culture Positive	72	72
Culture Negative	28	28
Total	100	100

The high culture positivity rate indicates a substantial burden of bloodstream infections among clinically suspected septicemia patients.

### 3.2 Distribution of Gram Positive and Gram Negative Isolates

Comparative analysis revealed that Gram-negative bacteria were more prevalent than Gram-positive bacteria.

**Table 2. Distribution of Bacterial Isolates**

Bacterial Group	Number	Percentage (%)
Gram Positive	30	41.67
Gram Negative	42	58.33
Total	72	100

The predominance of Gram-negative organisms may be associated with increasing hospital-acquired infections, invasive procedures, and widespread antimicrobial resistance.

### 3.3 Distribution of Gram Positive Isolates

Among Gram-positive bacteria, *Staphylococcus aureus* was the most frequently isolated pathogen.

**Table 3. Distribution of Gram Positive Bacteria**

Organism	Percentage (%)
<i>Staphylococcus aureus</i>	46.67
Coagulase-negative Staphylococci	26.67
<i>Enterococcus</i> spp.	16.67
<i>Streptococcus pneumoniae</i>	10.00

### 3.4 Distribution of Gram Negative Isolates

*Escherichia coli* was the predominant Gram-negative pathogen recovered from blood cultures.

**Table 4. Distribution of Gram Negative Bacteria**

Organism	Percentage (%)
Escherichia coli	35.71
Klebsiella pneumoniae	26.19
Pseudomonas aeruginosa	19.05
Salmonella Typhi	11.90
Acinetobacter baumannii	7.15

The predominance of E. coli and Klebsiella pneumoniae suggests an important contribution of urinary tract and healthcare-associated infections to bloodstream infection development.

### 3.5 Demographic Distribution

Age-wise and gender-wise analysis was performed to evaluate the distribution of bloodstream infections among different population groups.

**Table 5. Age-wise Distribution of Bloodstream Infections**

Age Group (Years)	Percentage (%)
0–20	16.67
21–40	34.72
41–60	30.56
>60	18.05

**Table 6. Gender-wise Distribution of Bloodstream Infections**

Gender	Percentage (%)
Male	59.72
Female	40.28

The highest prevalence was observed among patients aged 21–40 years, while males were affected more frequently than females.

### 3.6 Antimicrobial Susceptibility Pattern of Gram Positive Isolates

**Table 7. Antimicrobial Resistance among Gram Positive Isolates**

Antibiotic	Resistance (%)
Penicillin	80
Erythromycin	60
Ciprofloxacin	45
Cefoxitin	40
Vancomycin	5
Linezolid	2

High resistance to penicillin and erythromycin was observed, whereas vancomycin and linezolid remained highly effective.

### 3.7 Antimicrobial Susceptibility Pattern of Gram Negative Isolates

**Table 8. Antimicrobial Resistance among Gram Negative Isolates**

Antibiotic	Resistance (%)
Cefotaxime	75
Ceftriaxone	70
Ciprofloxacin	55
Gentamicin	40
Imipenem	15
Meropenem	10

The high resistance to third-generation cephalosporins suggests widespread occurrence of ESBL-producing organisms.

### 3.8 Detection of Multidrug Resistant Organisms

**Table 9. Detection of Resistant Organisms**

Resistant Organism	Number
MRSA	6
ESBL Producers	14
Carbapenem-Resistant Isolates	4

ESBL-producing organisms were more common than MRSA, indicating the growing burden of multidrug-resistant Gram-negative pathogens in bloodstream infections.

The findings of the present study highlight the increasing prevalence of antimicrobial resistance among bloodstream pathogens and emphasize the importance of routine blood culture, antimicrobial susceptibility testing, infection control practices, and antimicrobial stewardship programs.

### CONCLUSION

The present study demonstrated a high prevalence of bloodstream infections among clinically suspected septicemia patients, with a blood culture positivity rate of 72%. Gram negative bacteria were more prevalent than Gram positive bacteria, accounting for 58.33% and 41.67% of isolates, respectively. *Escherichia coli* emerged as the predominant Gram negative pathogen, whereas *Staphylococcus aureus* was the most common Gram positive isolate.

A significant level of antimicrobial resistance was observed among both groups of bacteria. The detection of MRSA, ESBL-producing organisms, and carbapenem-resistant isolates highlights the growing challenge of multidrug resistance in clinical settings. Despite this, vancomycin and linezolid remained highly effective against Gram positive bacteria, while carbapenems retained considerable activity against Gram negative isolates.

The study emphasizes the importance of early diagnosis through blood culture, routine antimicrobial susceptibility testing, strict infection control measures, and rational antibiotic prescribing practices. Continuous surveillance of bloodstream pathogens and resistance patterns is essential for improving patient management and reducing the burden of antimicrobial resistance.

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