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Phenotypic Detection of Extended-Spectrum β-Lactamase-Producing Clinical Isolates in Bloodstream Infections at a Tertiary Care Teaching Hospital in Tamil Nadu

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Abstract: Bloodstream infections (BSIs) remain a major cause of morbidity and mortality worldwide due to the invasion of pathogenic microorganisms into the bloodstream, often resulting in sepsis, septic shock, disseminated intravascular coagulation, multiple organ dysfunction, and death. The rapid emergence of Extended-Spectrum β-Lactamase (ESBL)-producing Gram-negative bacteria has become a significant therapeutic challenge, as these enzymes confer resistance to third-generation cephalosporins and other β-lactam antibiotics, thereby limiting treatment options. This study aimed to determine the prevalence of ESBL-producing multidrug-resistant Gram-negative clinical isolates recovered from bloodstream infections using phenotypic detection methods in a tertiary care teaching hospital in Tamil Nadu. A hospital-based cross-sectional study was conducted in the Department of Microbiology, where blood culture specimens obtained from patients with suspected bloodstream infections were processed using standard microbiological techniques. Bacterial identification was performed by conventional biochemical methods, and antimicrobial susceptibility testing was carried out using the Kirby–Bauer disk diffusion method in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines. Multidrug-resistant Gram-negative isolates were screened for ESBL production by the Double Disc Synergy Test (DDST). Among the isolates recovered, Gram-positive organisms predominated, with Staphylococcus species being the most common pathogens. Among Gram-negative bacteria, Escherichia coli, Klebsiella pneumoniae, and Pseudomonas aeruginosa were the frequently isolated organisms. A considerable proportion of multidrug-resistant Escherichia coli and Klebsiella pneumoniae isolates were confirmed as ESBL producers, demonstrating high resistance to third-generation cephalosporins while retaining comparatively better susceptibility to carbapenems and selected aminoglycosides. The findings highlight the growing burden of ESBL-producing pathogens causing bloodstream infections in Tamil Nadu and emphasize the importance of routine phenotypic detection, continuous antimicrobial resistance surveillance, implementation of antimicrobial stewardship programs, and institution-specific antibiotic policies. Early diagnosis and timely initiation of appropriate antimicrobial therapy are crucial to improving clinical outcomes and reducing the spread of multidrug-resistant organisms. **Keywords:** *Bloodstream infection, Extended-Spectrum β-Lactamase, ESBL, Multidrug-resistant bacteria, Escherichia coli, Klebsiella pneumoniae, Phenotypic detection, Double Disc Synergy Test, Antimicrobial resistance*

INTRODUCTION

Bloodstream infections (BSIs) are among the most serious healthcare-associated infections and remain a major cause of morbidity and mortality worldwide. They occur when pathogenic microorganisms, including bacteria and fungi, invade the bloodstream, leading to systemic inflammatory responses that may progress to sepsis and septic shock, disseminated intravascular coagulation (DIC), MODS - multiple organ dysfunction syndrome, and death if not diagnosed and treated promptly. Critically ill patients, particularly those admitted to intensive care units (ICUs), are at a significantly higher risk of developing BSIs due to prolonged hospitalization, invasive procedures, immunosuppression, and the frequent use of broad-spectrum antibiotics. In addition to adverse clinical outcomes, bloodstream infections substantially increase the duration of hospital stay,

healthcare expenditure, and the burden on healthcare systems.

The emergence of antimicrobial resistance has further complicated the management of bloodstream infections. Among resistant pathogens, Extended-Spectrum β-Lactamase (ESBL)-producing Gram-negative bacteria have become a significant public health concern. ESBLs are plasmid-mediated enzymes capable of hydrolyzing extended-spectrum cephalosporins, penicillins, and monobactams, thereby rendering these antibiotics ineffective. Although these enzymes are inhibited by β-lactamase inhibitors such as clavulanic acid, ESBL-producing organisms frequently exhibit resistance to multiple classes of antimicrobial agents, leaving limited therapeutic options.

The most common ESBL-producing organisms associated with bloodstream infections include *Escherichia coli*, *Klebsiella pneumoniae*, and *Proteus mirabilis*, though several other members of the Enterobacterales family have also been implicated.

The widespread dissemination of ESBL genes through plasmid-mediated horizontal gene transfer has accelerated the global spread of multidrug-resistant organisms in both hospital and community settings. Phenotypic detection of ESBL production remains an essential component of routine microbiological diagnosis, particularly in resource-limited laboratories.

The Clinical and Laboratory Standards Institute (CLSI) recommends standardized methods, including the Double Disc Synergy Test (DDST) and Combination Disc Test (CDT), for the confirmation of ESBL production in clinically significant Gram-negative isolates.

Early identification of these resistant pathogens enables clinicians to initiate appropriate antimicrobial therapy and implement effective infection prevention and control measures.

Carbapenems have long been regarded as the treatment of choice for severe infections caused by ESBL-producing organisms. However, the increasing emergence of carbapenem-resistant Enterobacterales (CRE) has become an alarming development, threatening the effectiveness of one of the last reliable classes of antibiotics available for treating multidrug-resistant Gram-negative infections. Consequently, antimicrobial stewardship, rational antibiotic prescribing, continuous surveillance of resistance patterns, and strict infection control practices have become essential strategies to limit the spread of resistant pathogens and preserve the efficacy of existing antimicrobial agents.

In India, including Tamil Nadu, the prevalence of ESBL-producing Gram-negative bacteria has increased considerably over the past decade owing to the indiscriminate use of antibiotics, inadequate infection control practices, and the widespread circulation of resistant strains. Despite the growing burden of antimicrobial resistance, regional epidemiological data on ESBL-producing bloodstream isolates remain limited. Understanding the local prevalence and antimicrobial susceptibility patterns of these organisms is essential for guiding empirical antibiotic therapy, formulating hospital antibiotic policies, and strengthening infection control measures.

Therefore, the present study was undertaken to determine the prevalence of Extended-Spectrum β-Lactamase-producing multidrug-resistant Gram-negative bacterial isolates recovered from bloodstream infections using phenotypic detection methods at a tertiary care teaching hospital in Tamil Nadu. The findings are expected to provide valuable information for clinicians and microbiologists in selecting appropriate antimicrobial therapy and developing effective

strategies to combat antimicrobial resistance in bloodstream infections.

METHODOLOGY

Study Design and Setting

A hospital-based cross-sectional study was conducted in the Department of Microbiology at a tertiary care teaching hospital in Tamil Nadu over a period of one year, from January 2024 to December 2024. The study aimed to determine the prevalence of Extended-Spectrum β-Lactamase (ESBL)-producing Gram-negative bacteria isolated from patients with clinically suspected bloodstream infections (BSIs). Ethical approval was obtained from the Institutional Ethics Committee before the commencement of the study.

Study Population

Patients aged 18 years and above who were clinically suspected of bloodstream infection and admitted to the intensive care units (ICUs), medical, surgical, obstetrics and gynaecology wards, or attending outpatient departments were included in the study. Patients already receiving prolonged antimicrobial therapy or those with inadequate blood samples were excluded.

Sample Collection

Blood specimens were collected under strict aseptic precautions by trained healthcare personnel using standard venipuncture techniques. Approximately 5–10 mL of blood was collected from each adult patient and immediately inoculated into blood culture bottles containing Brain Heart Infusion (BHI) broth in a 1:10 blood-to-broth ratio. The inoculated bottles were transported promptly to the microbiology laboratory for processing.

Microbiological Processing

Blood culture bottles were incubated aerobically at 37°C and examined daily for evidence of microbial growth, including turbidity, haemolysis, or gas production. Blind subcultures were performed after 24 hours irrespective of visible growth by inoculating samples onto Blood agar and MacConkey agar plates. Cultures showing no growth were incubated for seven days, followed by a final subculture before being reported as culture negative.

Positive cultures were subjected to Gram staining, colony morphology assessment, and conventional biochemical identification procedures according to standard microbiological protocols. Confirmed bacterial isolates were preserved for further antimicrobial susceptibility testing.

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method on Mueller–Hinton agar following the Clinical and Laboratory Standards Institute (CLSI) guidelines (2024). Zone diameters were interpreted according to CLSI breakpoints, and multidrug-resistant (MDR) isolates were identified based on resistance to at least one antimicrobial agent in three or more antimicrobial classes.

Phenotypic Detection of ESBL

All multidrug-resistant *Escherichia coli* and *Klebsiella pneumoniae* isolates exhibiting reduced susceptibility to cefotaxime or ceftazidime were screened for ESBL production using the Double Disc Synergy Test (DDST). A 0.5 McFarland bacterial suspension was inoculated uniformly on Mueller–Hinton agar plates. Discs containing cefotaxime (30 µg) and ceftazidime (30 µg), with and without clavulanic acid (10 µg), were placed 25 mm apart. Following incubation at 37°C for 18–24 hours, an increase of ≥5 mm in the inhibition zone around the combination disc compared with the cephalosporin disc alone was interpreted as confirmation of ESBL production in accordance with CLSI recommendations.

Statistical Analysis

The collected data were entered into Microsoft Excel and analysed using

Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics were used to summarize demographic characteristics, bacterial isolates, antimicrobial susceptibility patterns, and ESBL prevalence. Results were expressed as frequencies, percentages, means, and standard deviations wherever applicable.

RESULTS

A total of 181 patients with clinically suspected bloodstream infections (BSIs) were enrolled during the study period. Patients aged more than 60 years constituted the largest age group (44.2%), followed by those aged 41–60 years (37.6%) and 19–40 years (19.3%). Male patients accounted for 60.2% of the study population, whereas females represented 39.8%. Blood culture positivity was observed in 42 (23.2%) patients, while 139 (76.8%) samples showed no microbial growth (Table 1).

Table 1. Clinical and demographic characteristics of patients with suspected bloodstream infections (N = 181)

Characteristics	Frequency (n)	Percentage (%)
Age (years)		
19–40	35	19.3
41–60	68	37.6
>60	80	44.2
Gender		
Male	109	60.2
Female	72	39.8
Blood culture report		
Positive	42	23.2
Negative	139	76.8

Respiratory tract infections were identified as the most common primary source of bacteremia, accounting for 29.3% of cases, followed by genitourinary infections (21.5%) and metabolic disorders (12.2%). Cardiovascular infections (8.8%), gastrointestinal infections (7.2%), central nervous system infections (6.6%), skin and soft tissue infections (5.5%), immunosuppressive conditions (3.9%), autoimmune disorders (2.8%), and nonspecific conditions (1.7%) constituted the remaining clinical diagnoses (Table 2).

Table 2. Primary clinical diagnosis associated with bloodstream infections

Primary diagnosis	Frequency (n)	Percentage (%)
Respiratory tract infection	53	29.3
Genitourinary infection	39	21.5
Metabolic disorders	22	12.2
Cardiovascular infection	16	8.8
Gastrointestinal infection	13	7.2
Central nervous system infection	12	6.6
Skin and soft tissue infection	10	5.5
Immunosuppressive conditions	7	3.9
Autoimmune disorders	5	2.8
Nonspecific diagnosis	3	1.7

Among the 42 culture-positive blood samples, Gram-positive organisms predominated.

Staphylococcus aureus was the most frequently isolated pathogen (35.7%), followed by methicillin-resistant *Staphylococcus aureus* (MRSA) (19.0%), *Escherichia coli* (11.9%), *Klebsiella pneumoniae* (9.5%), *Pseudomonas aeruginosa* (7.1%), *Staphylococcus epidermidis* (4.8%), *Enterococcus faecalis* (4.8%), *Acinetobacter baumannii* (4.8%), *Staphylococcus hominis* (2.4%), *Acinetobacter lwoffii* (2.4%), *Enterobacter cloacae* (2.4%), *Candida glabrata* (2.4%), and *Candida tropicalis* (2.4%) (Table 3).

Table 3. Distribution of microorganisms isolated from positive blood cultures (n = 42)

Organism	Frequency (n)	Percentage (%)
Staphylococcus aureus	15	35.7
MRSA	8	19.0

Organism	Frequency (n)	Percentage (%)
Escherichia coli	5	11.9
Klebsiella pneumoniae	4	9.5
Pseudomonas aeruginosa	3	7.1
Staphylococcus epidermidis	2	4.8
Enterococcus faecalis	2	4.8
Acinetobacter baumannii	2	4.8
Staphylococcus hominis	1	2.4
Acinetobacter lwoffii	1	2.4
Enterobacter cloacae	1	2.4
Candida glabrata	1	2.4
Candida tropicalis	1	2.4

Antimicrobial susceptibility testing demonstrated that Gram-positive isolates showed complete susceptibility to linezolid and vancomycin. Gentamicin also exhibited good activity against MRSA and *Staphylococcus aureus*, whereas comparatively lower susceptibility was observed for ciprofloxacin, clindamycin, erythromycin, doxycycline, and tetracycline (Table 4).

Table 4. Antibiotic susceptibility pattern of Gram-positive bacterial isolates

Antibiotic	MRSA (n = 8)	*Staphylococcus aureus* (n = 15)	*Enterococcus* spp. (n = 2)
Cefoxitin	Resistant (100%)	Resistant (100%)	Resistant (100%)
Linezolid	8 (100%)	15 (100%)	2 (100%)
Vancomycin	8 (100%)	15 (100%)	2 (100%)
Gentamicin	7 (87.5%)	11 (73.3%)	1 (50.0%)
Ciprofloxacin	3 (37.5%)	4 (26.7%)	–
Clindamycin	3 (37.5%)	4 (26.7%)	–
Erythromycin	5 (62.5%)	4 (26.7%)	1 (50.0%)
Ampicillin	–	–	1 (50.0%)
Doxycycline	6 (75.0%)	4 (26.7%)	1 (50.0%)
Tetracycline	3 (37.5%)	4 (26.7%)	2 (100%)

Values represent number (%) of susceptible isolates.

Among Gram-negative isolates, imipenem, ertapenem, piperacillin–tazobactam, gentamicin, meropenem, and amikacin demonstrated the highest antimicrobial activity. Reduced susceptibility was observed against ceftazidime, cefotaxime, ciprofloxacin, aztreonam, amoxicillin–clavulanic acid, cefepime, and doxycycline, indicating a high prevalence of multidrug resistance among these isolates (Table 5).

Table 5. Antibiotic susceptibility pattern of Gram-negative bacterial isolates

Antibiotic	*E. coli* (n = 5)	*P. aeruginosa* (n = 3)	*K. pneumoniae* (n = 4)	*Acinetobacter* spp. (n = 1)
Imipenem	5 (100%)	3 (100%)	4 (100%)	1 (100%)
Ertapenem	5 (100%)	3 (100%)	4 (100%)	1 (100%)
Piperacillin–Tazobactam	5 (100%)	3 (100%)	4 (100%)	1 (100%)
Gentamicin	5 (100%)	3 (100%)	4 (100%)	1 (100%)
Levofloxacin	Resistant	2 (66.7%)	2 (50.0%)	1 (100%)
Cefuroxime sodium	Resistant	2 (66.7%)	3 (75.0%)	Resistant
Ciprofloxacin	Resistant	1 (33.3%)	1 (25.0%)	Resistant
Cefotaxime	Resistant	1 (33.3%)	1 (25.0%)	Resistant
Ampicillin	Resistant	1 (33.3%)	1 (25.0%)	Resistant

Antibiotic	*E. coli* (n = 5)	*P. aeruginosa* (n = 3)	*K. pneumoniae* (n = 4)	*Acinetobacter* spp. (n = 1)
Erythromycin	5 (100%)	1 (33.3%)	1 (25.0%)	Resistant
Cotrimoxazole	Resistant	1 (33.3%)	1 (25.0%)	Resistant
Meropenem	5 (100%)	2 (66.7%)	4 (100%)	Resistant
Amikacin	5 (100%)	2 (66.7%)	3 (75.0%)	1 (100%)
Azithromycin	Resistant	2 (66.7%)	1 (25.0%)	Resistant
Cefepime	Resistant	2 (66.7%)	1 (25.0%)	Resistant
Doxycycline	Resistant	1 (33.3%)	1 (25.0%)	1 (100%)
Amoxicillin–Clavulanic acid	Resistant	2 (66.7%)	1 (25.0%)	Resistant
Ceftazidime	1 (20.0%)	2 (66.7%)	3 (75.0%)	1 (100%)
Netilmicin	Resistant	2 (66.7%)	1 (25.0%)	Resistant
Aztreonam	1 (20.0%)	1 (33.3%)	1 (25.0%)	Resistant

Resistant indicates no susceptibility observed.

Phenotypic screening for ESBL production was performed using the Double Disc Synergy Test. Of the five *Escherichia coli* isolates tested, three (80%) were confirmed as ESBL producers, while two (50%) of the four *Klebsiella pneumoniae* isolates demonstrated ESBL production. The characteristic enhancement of the inhibition zone towards the clavulanic acid-containing disc confirmed ESBL production phenotypically.

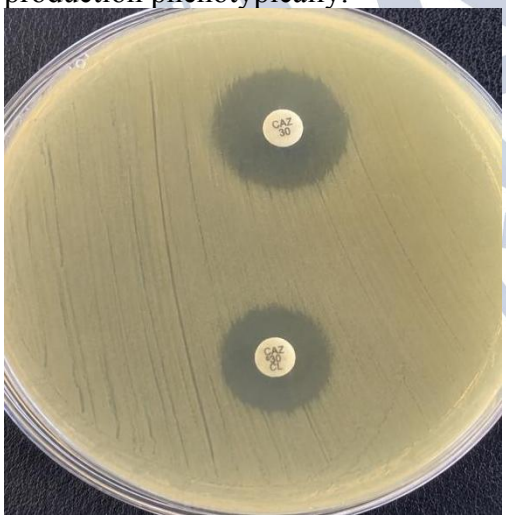

Figure 1. Phenotypic confirmation of Extended-Spectrum β-Lactamase (ESBL) production by the Double Disc Synergy Test showing an increase of ≥5 mm in the inhibition zone around the ceftazidime–clavulanic acid combination disc compared with ceftazidime alone, confirming ESBL production according to CLSI guidelines.

Analysis of epidemiological risk factors revealed that nosocomial isolates demonstrated substantially higher resistance to β-lactam/β-lactamase inhibitor combinations, carbapenems, aminoglycosides, and fluoroquinolones than healthcare-associated and community-acquired isolates. These findings indicate that hospital-acquired bloodstream infections remain an important reservoir for multidrug-resistant ESBL-producing pathogens.

Abbreviations: AMC – Amoxicillin–Clavulanic acid; TZP – Piperacillin–Tazobactam; IPM – Imipenem; MEM – Meropenem; AMK – Amikacin; GM – Gentamicin; CIP – Ciprofloxacin; LEV – Levofloxacin; MDR – Multidrug resistance.

Table 6. Epidemiological risk factors associated with ESBL-producing bloodstream isolates

Epidemiological category	No. of isolates	AMC (%)	TZP (%)	IPM (%)	MEM (%)	AMK (%)	GM (%)	CIP (%)	LEV (%)	MDR (<3 drug classes)
Nosocomial	36	33.0	18.3	33.9	91.7	91.7	44.0	–	–	High
Healthcare-associated	18	16.7	27.8	94.4	38.9	–	–	–	–	Moderate

Epidemiological category	No. of isolates	AMC (%)	TZP (%)	IPM (%)	MEM (%)	AMK (%)	GM (%)	CIP (%)	LEV (%)	MDR (<3 drug classes)
Community-acquired	3	Low	Low	Low	Low	Low	Low	Low	Low	Low

DISCUSSION

The present study demonstrated a blood culture positivity rate of 23.2% among patients with clinically suspected bloodstream infections (BSIs), highlighting the continued burden of bacteremia in hospitalized patients. Similar findings have been reported by Prabhu et al. (2010), who observed an isolation rate of 32.2%, with *Staphylococcus aureus* being the predominant pathogen, followed by *Escherichia coli*, coagulase-negative staphylococci (CoNS), *Klebsiella* spp., and *Pseudomonas* spp. Differences in isolation rates across studies may be attributed to variations in patient populations, blood culture techniques, timing of sample collection, and prior antimicrobial exposure.

In the present study, Gram-positive bacteria predominated among culture-positive isolates, with *Staphylococcus aureus* representing the most frequently isolated organism, followed by methicillin-resistant *Staphylococcus aureus* (MRSA). Among Gram-negative pathogens, *Escherichia coli* and *Klebsiella pneumoniae* were the leading causes of bloodstream infections. These findings are consistent with previous reports indicating that *Staphylococcus aureus* remains a major cause of hospital-acquired bloodstream infections, while members of the Enterobacterales continue to be the predominant Gram-negative pathogens associated with bacteremia.

Fungal bloodstream infections were also identified, with isolates of *Candida glabrata* and *Candida tropicalis* recovered from blood cultures. Although the prevalence was low, candidemia remains a clinically significant healthcare-associated infection. Berenholtz et al. (2004) reported that invasive Candida infections are commonly associated with prolonged hospitalization, broad-spectrum antibiotic therapy, immunosuppressive treatment, central venous catheterization, parenteral nutrition, and other invasive procedures. Early diagnosis and timely antifungal therapy are therefore essential to reduce mortality associated with candidemia.

The antimicrobial susceptibility profile observed in this study demonstrated that carbapenems, particularly imipenem and ertapenem, together with piperacillin–tazobactam, gentamicin, and amikacin, remained highly effective against most Gram-negative isolates. Likewise, vancomycin and linezolid retained excellent activity against Gram-positive organisms, including MRSA. However, increasing resistance to third-generation cephalosporins and fluoroquinolones among Gram-negative bacteria indicates the growing challenge of multidrug resistance in tertiary care hospitals.

Phenotypic detection of ESBL production using the Double Disc Synergy Test confirmed ESBL production in 80% of the tested *Escherichia coli* isolates and 50% of the *Klebsiella pneumoniae* isolates. These findings are comparable to those reported by Shakya et al. (2017), who also demonstrated a high prevalence of ESBL-producing Enterobacterales among bloodstream isolates. Other investigators, including Gilbert et al. (2013), have reported even higher ESBL prevalence rates, emphasizing the expanding global burden of antimicrobial resistance.

The Clinical and Laboratory Standards Institute (CLSI) recommends a two-step approach for phenotypic

detection of ESBL production. Initial screening is based on reduced susceptibility to extended-spectrum cephalosporins such as cefotaxime, ceftriaxone, ceftazidime, cefpodoxime, and aztreonam. Confirmation is achieved by demonstrating a ≥5 mm increase in the inhibition zone diameter around cephalosporin discs combined with clavulanic acid compared with cephalosporin discs alone. This standardized approach remains a reliable and cost-effective method for routine ESBL detection in clinical microbiology laboratories, particularly in resource-limited settings.

Analysis of epidemiological characteristics in the present study revealed that hospital-acquired bloodstream isolates exhibited greater multidrug resistance than healthcare-associated and community-acquired isolates. Similar observations were reported by Ammerlaan et al. (2013), who identified advanced age, previous antimicrobial exposure, liver disease, male sex, and *Klebsiella pneumoniae* bacteremia as significant predictors of multidrug-resistant bloodstream infections. Furthermore, inappropriate empirical antimicrobial therapy remains common among patients infected with ESBL-producing organisms, contributing to adverse clinical outcomes.

The emergence of ESBL-producing Gram-negative bacteria poses a significant therapeutic challenge because these organisms frequently exhibit resistance to multiple antimicrobial classes. Inappropriate and indiscriminate use of antibiotics, over-the-counter availability of antimicrobial agents, inadequate infection prevention practices, and insufficient antimicrobial resistance surveillance contribute substantially to the increasing prevalence of resistant pathogens, particularly in developing countries. Continuous microbiological surveillance and periodic monitoring of local antimicrobial susceptibility patterns are therefore essential for guiding empirical therapy.

Bloodstream infections continue to be associated with prolonged hospitalization, increased healthcare costs, sepsis, and high mortality, particularly among critically ill patients. Early microbiological diagnosis, prompt initiation of appropriate antimicrobial therapy, implementation of antimicrobial stewardship programs, and strict infection prevention and control measures are fundamental to improving patient outcomes. Routine screening for ESBL production should be incorporated into clinical microbiology laboratories, as failure to identify these organisms may result in inappropriate use of cephalosporins and treatment failure.

Furthermore, the increasing emergence of AmpC β-lactamase-producing organisms and carbapenem-resistant Enterobacterales highlights the necessity for continuous antimicrobial resistance surveillance, timely laboratory diagnosis, and effective antimicrobial stewardship to optimize patient management and curb the spread of multidrug-resistant pathogens.

CONCLUSION

Bloodstream infections remain a major cause of morbidity and mortality, particularly among critically ill and hospitalized patients. The present study demonstrated a blood culture positivity rate of 23.2%, with *Staphylococcus aureus* being the predominant Gram-positive pathogen, while *Escherichia coli* and *Klebsiella pneumoniae* were the most frequently isolated Gram-negative organisms. A high proportion of *Escherichia coli* (80%) and *Klebsiella pneumoniae* (50%) isolates were identified as Extended-Spectrum β-Lactamase (ESBL) producers using the phenotypic Double Disc Synergy Test, highlighting the increasing prevalence of

multidrug-resistant pathogens in bloodstream infections.

The antimicrobial susceptibility profile demonstrated that carbapenems, piperacillin–tazobactam, vancomycin, aminoglycosides, and linezolid remained highly effective against the majority of bacterial isolates.

However, increasing resistance to third-generation cephalosporins and fluoroquinolones underscores the urgent need for continuous antimicrobial resistance surveillance and routine ESBL detection in clinical microbiology laboratories.

Early diagnosis, prompt initiation of appropriate antimicrobial therapy, strict infection prevention and control practices, and implementation of antimicrobial stewardship programmes are essential to improve clinical outcomes and reduce the spread of multidrug-resistant organisms. Regular monitoring of local antimicrobial susceptibility patterns should guide empirical antibiotic therapy and assist in developing evidence-based institutional antibiotic policies. Continued surveillance of ESBL-producing pathogens is crucial for minimizing treatment failures and improving patient care in tertiary healthcare settings.

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