

KLEBSIELLA PNEUMONIAE AS A PREDOMINANT CAUSE OF BLOODSTREAM INFECTIONS: A PROSPECTIVE ANALYSIS OF PREVALENCE AND ANTIMICROBIAL RESISTANCE IN A TERTIARY CARE HOSPITAL

Medical Microbiology

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ABSTRACT

Background: Bloodstream infections (BSIs) are a major cause of morbidity and mortality in hospitalized patients. *Klebsiella pneumoniae* is a major BSI pathogen and increasing antimicrobial resistance limits therapeutic options. **Objectives:** To determine the prevalence, antimicrobial susceptibility pattern, and multidrug resistance (MDR) profile of *K. pneumoniae* among blood culture-positive cases of septicemia. **Materials and Methods:** This prospective observational study was conducted over a period of 24 months (July 2023 to June 2025) in the Department of Microbiology of a tertiary care hospital in Maharashtra. A total of 843 blood culture samples were processed by conventional methods. Isolates were identified by Gram staining; colony morphology and biochemical tests. Antimicrobial susceptibility testing was performed by Kirby-Bauer disk diffusion and interpreted as per CLSI 2023. MDR was defined as resistance to at least one agent in three or more antimicrobial classes. **Results:** Out of 843 cultures, 212 (25.14%) were positive. *K. pneumoniae* accounted for 61 (28.77%) positive isolates. Most *K. pneumoniae* isolates were from neonates (75.4%) and intensive care units (60.7%). Resistance was high to cephalosporins and fluoroquinolones; comparatively better susceptibility was observed with piperacillin-tazobactam and carbapenems. Approximately 70% of isolates were MDR. **Conclusion:** *Klebsiella pneumoniae* was identified as a predominant cause of bloodstream infections in the present study, particularly among neonatal and ICU patients. The high prevalence of multidrug resistance highlights the urgent need for continuous microbiological surveillance, rational antibiotic use, and effective antimicrobial stewardship programs to curb the growing threat of antimicrobial resistance.

KEYWORDS

Klebsiella Pneumoniae, Bloodstream Infections, Septicemia, Antimicrobial Resistance, Multidrug Resistance

INTRODUCTION

Among the Gram-negative bacilli, *Klebsiella pneumoniae* has emerged as a prominent pathogen causing both community-acquired and healthcare-associated bloodstream infections. It is particularly associated with severe infections in neonates, elderly individuals, immunocompromised patients, and those admitted to intensive care units. The organism's ability to acquire and disseminate resistance determinants has led to increasing reports of multidrug-resistant (MDR) strains, severely restricting therapeutic options.^{1,2,3}

The rising resistance to third-generation cephalosporins, fluoroquinolones, and aminoglycosides among *Klebsiella pneumoniae* isolates, largely attributed to extended-spectrum β -lactamase (ESBL) production and other resistance mechanisms, is a matter of serious concern. Although carbapenems remain the cornerstone for treating severe infections caused by resistant strains, reports of reduced susceptibility even to these agents are increasingly being documented.^{4,5}

Institution-specific surveillance studies play a crucial role in understanding local epidemiological trends and antimicrobial susceptibility patterns, thereby guiding empirical therapy and antimicrobial stewardship strategies. However, data on *Klebsiella pneumoniae* bloodstream infections from tertiary care centres, especially focusing on neonatal and ICU settings, remain limited.

The present study was undertaken to analyse the prevalence of *Klebsiella pneumoniae* among blood culture-positive cases of septicemia and to assess its antimicrobial susceptibility and multidrug resistance patterns in a tertiary care hospital in Maharashtra.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted in the Department of Microbiology of a tertiary care hospital in Maharashtra over a period of 24 months, from July 2023 to June 2025, following approval from institutional ethics committee.

Study Population

Blood culture samples received from patients of all age groups with clinical suspicion of septicemia, admitted to various wards and intensive care units of the hospital, were included in the study. Patients were considered clinically suspected of septicemia based on the presence of signs and symptoms suggestive of systemic infection, such as fever or hypothermia, chills, tachycardia, tachypnea, altered sensorium, hypotension, and other features of systemic inflammatory

response, as assessed by the treating clinician. In neonates, clinical suspicion was based on features including temperature instability, poor feeding, lethargy, respiratory distress, apnoea, and other signs suggestive of neonatal sepsis.

Blood Culture Processing

A total of 843 blood culture samples were processed during the study period. Blood samples were collected under strict aseptic precautions. Two blood samples were obtained from different venepuncture sites prior to initiation of antibiotic therapy.

The volume of blood collected was:

Adults: 8–10 mL

Paediatric Patients: 2–4 mL

Samples were inoculated into conventional blood culture media and incubated aerobically at 37°C for up to 7 days. Bottles were observed daily for signs of growth. Subcultures were performed on appropriate solid media when growth was suspected.

Identification of Isolates

Bacterial isolates were identified based on colony morphology, Gram staining, and standard biochemical tests following conventional microbiological procedures. *Klebsiella pneumoniae* was identified by characteristic biochemical reactions.

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was performed by the Kirby-Bauer disk diffusion method on Mueller-Hinton agar. Results were interpreted as per Clinical and Laboratory Standards Institute (CLSI) guidelines, 2023.

Definition of Multidrug Resistance

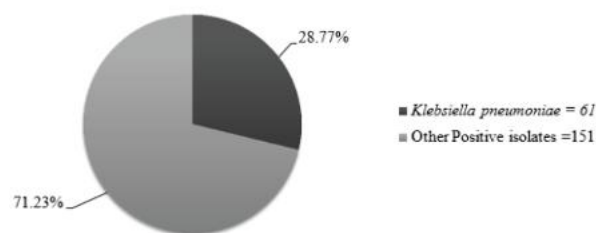
Multidrug resistance (MDR) was defined as resistance to at least one drug of three or more classes of antimicrobial agents.

Statistical Analysis

Data were analyzed using descriptive statistics. Statistical significance was assessed using the Chi-square test and a p-value <0.05 was considered significant.

RESULTS

During the study period of 24 months (July 2023 to June 2025), a total of 843 blood culture samples were received from clinically suspected cases of septicemia. Of these, 212 samples yielded bacterial growth, giving an overall blood culture positivity rate of 25.14%.

Figure 1: Prevalence of *Klebsiella pneumoniae*

Among the 212 culture-positive isolates, *Klebsiella pneumoniae* was the most frequently isolated organism, accounting for 61 isolates (28.77%), thereby emerging as the predominant cause of bloodstream infections in the present study.

Table 1. Age-wise Distribution of *Klebsiella Pneumoniae* Bloodstream Infections

Age group	Number of isolates (n=61)	Percentage (%)
Neonates	46	75.4
Infants	14	22.9
Children	1	1.6
Adults & Elderly	0	0

The age-wise distribution highlights a significantly higher burden of *Klebsiella pneumoniae* bloodstream infections in early life, particularly in neonates.

Table 2. Distribution of *Klebsiella Pneumoniae* Isolates According to Hospital Setting

Hospital setting	Number of isolates	Percentage (%)
ICU	37	60.7
Wards	24	39.3

This finding indicates a higher prevalence of *Klebsiella pneumoniae* bloodstream infections among critically ill patients.

Table 3. Antimicrobial Susceptibility Pattern of *Klebsiella Pneumoniae* Isolates (n=61)

Antibiotic	Sensitive (S)	Intermediate (I)	Resistant (R)
TIER 1			
Cefazolin	4 (6.6%)	7 (11.5%)	50 (82.0%)
Ceftriaxone	7 (11.5%)	9 (14.8%)	45 (73.8%)
Amoxicillin-Clavulanate	6 (9.8%)	10 (16.4%)	45 (73.8%)
Ampicillin-Sulbactam	10 (16.4%)	7 (11.5%)	44 (72.1%)
Piperacillin-Tazobactam	33 (54.1%)	5 (8.2%)	23 (37.7%)
Gentamicin	31 (50.8%)	6 (9.8%)	24 (39.3%)
Ciprofloxacin	7 (11.5%)	16 (26.2%)	38 (62.3%)
Levofloxacin	12 (19.7%)	15 (24.6%)	34 (55.7%)
Trimethoprim-Sulfamethoxazole	6 (9.8%)	17 (27.9%)	38 (62.3%)
TIER 2			
Cefuroxime	4 (6.6%)	15 (24.6%)	42 (68.9%)
Cefepime	13 (21.3%)	13 (21.3%)	35 (57.4%)
Ertapenem	29 (47.5%)	9 (14.8%)	23 (37.7%)
Imipenem	25 (41.0%)	14 (23.0%)	22 (36.1%)
Meropenem	27 (44.3%)	14 (23.0%)	20 (32.8%)
Tobramycin	26 (42.6%)	13 (21.3%)	22 (36.1%)
Amikacin	33 (54.1%)	10 (16.4%)	18 (29.5%)
Cefoxitin	16 (26.2%)	8 (13.1%)	37 (60.7%)
Tetracycline	17 (27.9%)	13 (21.3%)	31 (50.8%)

Antimicrobial susceptibility testing of *Klebsiella pneumoniae* isolates demonstrated high levels of resistance to commonly used antibiotics, particularly third-generation cephalosporins, fluoroquinolones, and aminoglycosides. Resistance to ceftriaxone, cefazolin, cefuroxime, and Cefepime was notably high, indicating widespread reduced susceptibility to cephalosporins. Similarly, considerable resistance was observed to ciprofloxacin and levofloxacin. Among aminoglycosides, gentamicin showed higher resistance compared to amikacin. Better susceptibility was observed with piperacillin-tazobactam and carbapenems (imipenem, meropenem, and ertapenem), although reduced susceptibility to these agents was also noted in a subset of isolates. Multidrug resistance, defined as resistance to at least one agent in three or more antimicrobial classes, was observed in approximately 70% of the *Klebsiella pneumoniae* isolates.

DISCUSSION

Bloodstream infections remain a major cause of morbidity and mortality worldwide, particularly in hospitalized patients, neonates, and those admitted to intensive care units. The present prospective study provides valuable insight into the epidemiology and antimicrobial resistance pattern of *Klebsiella pneumoniae* causing bloodstream infections in a tertiary care hospital in Maharashtra.^{1,4}

An important observation in the current study was the marked predominance of *Klebsiella pneumoniae* bloodstream infections among neonates, who accounted for 75.4% of the isolates. Similar findings have been documented in neonates across India, where *Klebsiella pneumoniae* is frequently implicated in early- and late-onset neonatal sepsis. Factors such as prematurity, low birth weight, prolonged hospitalization, invasive procedures, and immature immune defences contribute to the increased vulnerability of neonates to invasive infections caused by this organism.^{6,7,8,9}

The distribution of isolates according to hospital setting revealed that a majority (60.7%) of *Klebsiella pneumoniae* bloodstream infections occurred in ICU patients. This observation underscores the role of intensive care units as high-risk areas for the acquisition and transmission of multidrug-resistant organisms. The frequent use of broad-spectrum antibiotics, prolonged hospital stays, mechanical ventilation, and invasive devices in ICU settings create an environment conducive to the selection and spread of resistant *Klebsiella* strains.^{10,11}

High levels of resistance were noted to third-generation cephalosporins, fluoroquinolones, and aminoglycosides, which are commonly used as empirical therapy for suspected septicemia. This resistance pattern is suggestive of widespread extended-spectrum β -lactamase (ESBL) production among *Klebsiella pneumoniae* isolates. Similar resistance trends have been widely reported in other studies in India, highlighting the declining utility of these antibiotics in the treatment of serious Gram-negative infections.^{4,12}

Relatively better susceptibility was observed to piperacillin-tazobactam and carbapenems, including imipenem, meropenem, and ertapenem. However, the presence of reduced susceptibility even to these agents in a subset of isolates is alarming and reflects the emerging threat of carbapenems resistance. Carbapenems continue to remain the mainstay of therapy for severe infections caused by multidrug-resistant *Klebsiella pneumoniae*, but their indiscriminate use may further accelerate resistance.^{13,14,15,16}

Multidrug resistance was observed in approximately 70% of *Klebsiella pneumoniae* isolates in the present study. This high prevalence of MDR strains significantly limits therapeutic options and poses a major challenge to clinicians. Comparable MDR rates have been reported from several tertiary care centres in India, emphasizing that antimicrobial resistance among *Klebsiella pneumoniae* is no longer an isolated phenomenon but a widespread problem.^{17,18,19}

CONCLUSION

Klebsiella pneumoniae emerged as the predominant cause of bloodstream infections in the present study, with a substantial burden observed among neonates and patients admitted to intensive care units. The high prevalence of resistance to commonly used antimicrobial agents and the alarming proportion of multidrug-resistant isolates underscore the growing therapeutic challenge posed by this pathogen in tertiary care settings. These findings emphasize the critical importance of continuous institutional surveillance of bloodstream infections and antimicrobial resistance patterns. Regular generation of local antibiograms is essential to guide appropriate empirical therapy, particularly in high-risk areas such as neonatal units and intensive care settings. Furthermore, strict adherence to infection prevention and control practices, judicious antibiotic use, and the implementation of structured antimicrobial stewardship programs are imperative to contain the spread of multidrug-resistant *Klebsiella pneumoniae* and to improve clinical outcomes.

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