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"ANTIBIOTIC SUSCEPTIBILITY TRENDS AMONG KLEBSIELLA PNEUMONIAE ISOLATES IN CLINICAL SPECIMENS AT A TERTIARY CARE HOSPITAL"

Medical Microbiology

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ABSTRACT

Background: Klebsiella pneumoniae is a leading etiological agent in both community- and hospital-acquired infections, now complicated by increased antibiotic resistance. **Methods:** A retrospective study in the Department of Microbiology, M.P. Shah Government Medical College, included 600 non-repetitive K. pneumoniae isolates (December 2024–May 2025). Data from WHONET surveillance were analyzed using CLSI 2024 guidelines. **Results:** Of 600 isolates, most originated from urine (35.8%) and pus (27.0%). Males represented 53.1% of cases. Patients aged 51–70 years had the highest burden. Over 69% of isolates were resistant to third-generation cephalosporins. Carbapenem sensitivity exceeded 92%. **Conclusion:** High resistance rates to first-line antibiotics underscore the urgent need for robust antibiotic stewardship. Judicious use of carbapenems is recommended.

KEYWORDS

Klebsiella pneumoniae, antimicrobial resistance, carbapenem, cephalosporin, stewardship

INTRODUCTION

Klebsiella pneumoniae has emerged as one of the most significant pathogens implicated in both community and hospital-acquired infections, including pneumonia, urinary tract infections, bacteremia, and wound infections (1). Its clinical importance has escalated due to the rapidly increasing prevalence of multidrug-resistant strains, which exhibit resistance to several first-line and last-resort antibiotics, critically threatening patient outcomes (2,3). The underlying mechanisms of resistance in K. pneumoniae are notably diverse and include the production of extended-spectrum beta-lactamases (ESBLs), AmpC beta-lactamases, carbapenemases, and the acquisition of multiple resistance genes through horizontal gene transfer, biofilm formation, and mutations affecting porins and efflux pumps (2,4).

The ongoing evolution of antibiotic resistance among K. pneumoniae isolates has resulted in high rates of therapeutic failure, as studies from tertiary care hospitals worldwide consistently report alarming levels of multidrug resistance, particularly to beta-lactams, cephalosporins, aminoglycosides, and fluoroquinolones (1,5,6). This global trend necessitates regular surveillance of antimicrobial susceptibility patterns among clinical isolates in tertiary care settings to guide effective infection control strategies and optimize therapy (3,7,8). Periodic monitoring also facilitates early detection of emerging resistance mechanisms and informs stewardship programs aimed at preventing the further spread of resistant strains (2,3,7).

MATERIALS AND METHODS

Study Design And Period

A retrospective, observational study conducted from December 2024 to May 2025 at the M.P. Shah Government Medical College, Jamnagar.

Inclusion Criteria

- All clinical specimens (urine, pus, sputum, blood, tracheal aspirates, fluids, tissues)
- All age groups and genders
- Confirmed K. pneumoniae isolates

Exclusion Criteria

- Duplicate samples from the same patient
- Inadequately processed samples
- Non-K. pneumoniae isolates

Laboratory Methods

Specimens were cultured and processed within two hours. Species identification used colony morphology, Gram stain, and standard biochemical tests. Susceptibility testing employed the Kirby-Bauer disc diffusion method on Mueller-Hinton agar, interpreted per CLSI 2024.Antimicrobial susceptibility was determined for Ceftazidime, Cefepime Piperacillin/ Tazobactam (PTZ), Ciprofloxacin, Levofloxacin, Amoxiclav, gentamicin, Tetracycline, Cotrimoxazole, Cefuroxime, Cefotaxime, Ceftriaxone, Ampicillin Sulbactam, Ertapenam, Amikacin(AK), Meropenem(MP), Imipenem(IPM), Ceftazidime-avibactam, Aztreonam, Nitrofurantoin .

Results were interpreted according to Latest CLSI guidelines.

Data Analysis

WHONET database data were analyzed in Microsoft Excel to calculate resistance and sensitivity percentages.

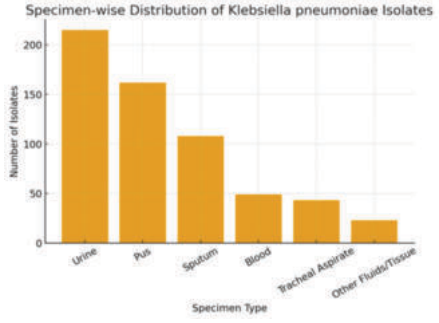
Ethical Approval

Institutional review board approval obtained; patient consent was waived for this de-identified retrospective analysis.

RESULTS

Table 1: Specimen-wise Distribution

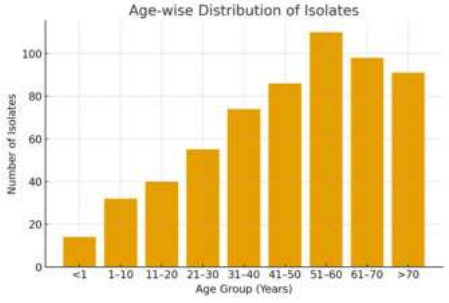
Specimen Type	No. of Isolates	Percentage (%)
Urine	215	35.8
Pus	162	27.0
Sputum	108	18.0
Blood	49	8.2
Tracheal Aspirate	43	7.1
Other Fluids/Tissue	23	3.9
Total	600	100.0



Out of 600 isolates of Klebsiella pneumoniae, the highest number were recovered from urine samples (215, 35.8%), followed by pus samples (162, 27%). Sputum accounted for 18%, while blood and tracheal aspirates contributed 8.2% and 7.1% respectively. Other fluids and tissues made up 3.9%. This highlights that urinary tract and wound infections were the predominant clinical presentations.

Table 2: Age-wise Distribution

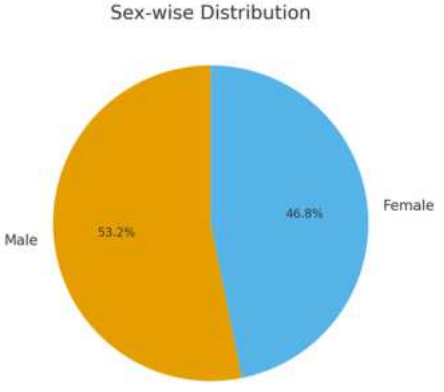
Age Group (Years)	No. of Isolates	Percentage (%)
<1	14	2.3
1–10	32	5.3
11–20	40	6.7
21–30	55	9.2
31–40	74	12.3
41–50	86	14.3
51–60	110	18.3
61–70	98	16.3
>70	91	15.2
Total	600	100.0



Isolates were found across all age groups, with the highest prevalence in patients aged 51–60 years (18.3%), followed closely by 61–70 years (16.3%) and >70 years (15.2%). Only 2.3% of isolates were from infants (<1 year). The data suggest that middle-aged and elderly populations were disproportionately affected, reflecting higher susceptibility in these groups.

Table 3: Sex-wise Distribution

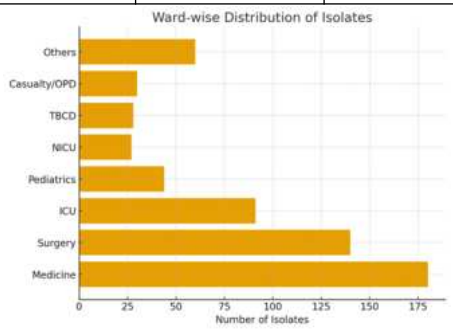
Sex	No. of Isolates	Percentage (%)
Male	319	53.1
Female	281	46.9
Total	600	100.0



Of the total cases, 319 (53.1%) were males and 281 (46.9%) were females, showing a slight male predominance. This may relate to gender-specific health-seeking behavior and underlying co-morbidities.

Table 4: Ward-wise Distribution

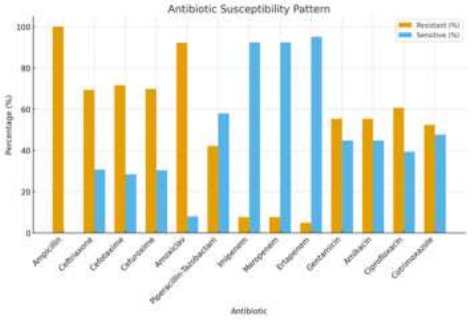
Ward / Unit	No. of Isolates	Percentage (%)
Medicine	180	30.0
Surgery	140	23.3
ICU	91	15.2
Pediatrics	44	7.3
NICU	27	4.5
TBCD	28	4.7
Casualty / OPD	30	5.0
Others	60	10.0
Total	600	100.0



The highest number of isolates originated from the Medicine ward (30%), followed by Surgery (23.3%). ICU accounted for 15.2% of isolates, reflecting its role as a high-risk environment for multidrug-resistant organisms. Pediatric wards and NICU contributed smaller proportions (7.3% and 4.5% respectively), while the TBCD, Casualty/OPD, and other wards contributed the remaining.

Table 5: Antibiotic Susceptibility Pattern

Antibiotic	Resistant (%)	Sensitive (%)
Ceftriaxone	69.3	30.7
Cefotaxime	71.6	28.4
Cefuroxime	69.7	30.3
Amoxicillin-Clavulanate	92.1	7.9
Piperacillin-Tazobactam	42.1	57.9
Imipenem	7.6	92.4
Meropenem	7.6	92.4
Ertapenem	4.9	95.1
Gentamicin	55.3	44.7
Amikacin	55.3	44.7
Ciprofloxacin	60.7	39.3
Cotrimoxazole	52.4	47.6



High levels of resistance were observed for third-generation cephalosporins, including Cefotaxime (71.6%), Ceftriaxone (69.3%), and Cefuroxime (69.7%). Amoxicillin-Clavulanate also showed poor activity, with 92.1% resistance. Moderate resistance was noted against aminoglycosides (Gentamicin and Amikacin, both 55.3%) and fluoroquinolones (Ciprofloxacin, 60.7%). In contrast, Carbapenems remained highly effective, with sensitivity rates of 92.4% for Imipenem and Meropenem, and 95.1% for Ertapenem. Piperacillin-Tazobactam retained moderate activity (57.9% sensitive). These findings highlight the limited role of first-line antibiotics and the continued importance of carbapenems as the drugs of choice in severe infections.

Table 6: Ward-wise Resistance Pattern

Ward / Unit	Ceftriaxone R (%)	Ciprofloxacin R (%)	Imipenem R (%)
ICU	76.9	68.1	12.1
Medicine	71.1	63.0	9.4
Surgery	65.7	58.2	6.7
Pediatrics	61.4	50.0	4.5
NICU	63.0	47.8	2.7
OPD / Casualty	58.3	43.7	3.3

ICU and Medicine units showed the highest resistance, while NICU and Pediatrics had lower resistance rates. These data support ward-specific antibiotic policies.

DISCUSSION

Overview. This study of 600 non-repetitive Klebsiella pneumoniae isolates demonstrated a high burden of infection from urine and pus specimens, with a male predominance and the greatest case load in patients aged 51–70 years. Antimicrobial resistance (AMR) was marked: third-generation cephalosporin resistance exceeded ~69%, and fluoroquinolone resistance was ~61%. Carbapenems (imipenem, meropenem, ertapenem) retained >92% susceptibility overall, while piperacillin–tazobactam showed moderate activity (~58% susceptible). Ward-wise analysis revealed the highest resistance in ICU and Medicine units, underpinning the need for ward-specific policies.

Table 7: Comparison Of Resistance Across Indian Studies

Study / Region	Ceftriaxone R (%)	Ciprofloxacin R (%)	Imipenem R (%)	Amikacin R (%)
Present Study (2025)	69.3	60.7	7.6	55.3
Sharanya et al. [9]	64.8	55.2	9.5	52.4
Shireen Rana et al. [10]	66.1	62.0	10.2	60.3
Manikandan et al. [11]	70.4	59.8	12.5	58.7
Susethira et al. [12]	68.7	61.3	8.1	53.1

Sharanya et al. [9]. Reported ceftriaxone (64.8%) and ciprofloxacin (55.2%) resistance comparable to our figures (69.3% and 60.7%), with slightly higher imipenem resistance (9.5% vs. 7.6%).

Shireen Rana et al. [10]. Observed similar third-generation cephalosporin resistance (66.1%) and marginally higher ciprofloxacin resistance (62.0%), alongside imipenem resistance around 10.2%, again modestly above our rate.

Manikandan et al. [11]. Documented the highest imipenem resistance among comparators (12.5%), with ceftriaxone and ciprofloxacin resistance (70.4% and 59.8%) closely tracking our estimates.

Susethira et al. [12]. Showed ceftriaxone and ciprofloxacin resistance (68.7% and 61.3%) very close to our findings, with imipenem resistance (8.1%) within one percentage point of ours.

Ward-wise Patterns And Stewardship Implications

ICU exhibited the greatest resistance burden (e.g., ceftriaxone 76.9%, ciprofloxacin 68.1%, imipenem 12.1%), followed by Medicine. These gradients likely reflect selection pressure from broad-spectrum therapy, device use, and case complexity. Recommended actions include: (i) enforcing ESCALATION-then-DE-ESCALATION using early cultures; (ii) restricting carbapenems and reserving ceftazidime–avibactam for documented indications; (iii) unit-specific antibiograms updated quarterly; and (iv) strengthened hand hygiene, catheter bundles, and ventilator-associated pneumonia prevention packages.

Clinical Implications For Empirical Therapy

For severe sepsis or ICU suspected K. pneumoniae infections in this setting, empirical carbapenem therapy remains reasonable while cultures are pending, but should be de-escalated based on susceptibility results. Piperacillin–tazobactam may be considered for non-critical infections when local susceptibility remains ≥60%, acknowledging risk of ESBL. Avoid ampicillin and amoxicillin–clavulanate empirically. Gentamicin/amikacin can serve as adjuncts where renal function permits.

Strengths And Limitations

Strengths include a robust sample size (n=600) over six months and comprehensive ward-wise analysis. Limitations include single-center design, lack of molecular typing for ESBL/carbapenemase genes, and absence of clinical outcome correlation. Future work should integrate genotypic characterization and assess time-trends beyond six months.

CONCLUSION

The study's resistance landscape mirrors contemporary Indian data, with widespread resistance to β-lactams and fluoroquinolones but preserved carbapenem activity. Targeted stewardship and unit-level interventions are essential to curb further resistance escalation.

The complete loss of activity of ampicillin and poor performance of β-lactam/β-lactamase inhibitor combinations (e.g., amoxicillin–clavulanate) is consistent with widespread β-lactamase production in K. pneumoniae, including ESBL and AmpC enzymes. The high resistance to cefotaxime, ceftriaxone, and cefuroxime mirrors ESBL prevalence, while moderate resistance to aminoglycosides and ciprofloxacin likely reflects co-selection and plasmid-mediated determinants. Carbapenem susceptibility >90% indicates preserved efficacy in this setting, but the non-trivial carbapenem resistance (≈7–8%)—especially higher in ICU—signals emerging carbapenemase activity and/or porin-efflux changes.

REFERENCES

1. Pathology and Microbiology. Antibiogram of Klebsiella pneumoniae isolated from various clinical samples of hospitalized patients in a tertiary care hospital of North India. J Pathol Microbiol Res. 2019.
2. Characteristics of antibiotic resistance mechanisms and genes of Klebsiella pneumoniae. PubMed Central (NCBI). 2023.
3. Antimicrobial susceptibility profiles of Klebsiella pneumoniae. PubMed Central (NCBI). 2024.
4. Klebsiella pneumoniae: A growing threat in the era of antimicrobial resistance. ScienceDirect. 2025.
5. Antibiotic resistance and developments against K. pneumoniae. Dove Medical Press. 2024.
6. A retrospective study of the antimicrobial susceptibility patterns of Klebsiella pneumoniae. Front Microbiol. 2025.
7. Global trends of antimicrobial resistance and virulence of Klebsiella pneumoniae. Nature. 2025.
8. Evolution of antimicrobial resistance in Klebsiella pneumoniae over time. PubMed Central (NCBI). 2024.
9. Sharanya K, et al. Prevalence and antibiotic susceptibility pattern among Klebsiella isolates. Indian J Microbiol Res. 2018;5(2):208-12.
10. Shireen Rana, et al. ESBL-producing Klebsiella pneumoniae: prevalence and resistance. J Clin Diagn Res. 2016.
11. Manikandan C, Amsath A. Antibiotic susceptibility of K. pneumoniae in urinary tract infections. Int J Curr Microbiol App Sci. 2013;2(8):330-7.
12. Susethira R, et al. Drug resistance in Klebsiella pneumoniae. Indian J Infect Dis. 2020.
13. Manjula NG, et al. ESBL Klebsiella in urine of pregnant women. J Clin Diagn Res. 2014;8(10):DC08-11.
14. All India Institute of Medical Sciences (AIIMS), New Delhi. Carbapenem resistance surveillance in gram-negative pathogens. 2019.
15. Gandra S, Mojica N, Klein EY, Ashok A, Nerurkar V, Kumari M, et al. Trends in antibiotic resistance among major bacterial pathogens isolated from blood cultures tested at a large private laboratory network in India, 2008–2014. Int J Infect Dis. 2016;50:75–82.
16. Datta S, Wattal C, Goel N, Oberoi JK, Raveendran R, Prasad KJ. A ten year analysis of multi-drug resistant blood stream infections caused by Escherichia coli & Klebsiella pneumoniae in a tertiary care hospital. Indian J Med Res. 2012;135(6):907–12.
17. Veeraraghavan B, Shankar C, Karunasree S, Kumari S, Ravi R, Ralph R. Carbapenem-resistant Klebsiella pneumoniaeisolated from bloodstream infection: Indian experience. Pathog Glob Health. 2017;111(5):240–6.
18. Gupta E, Mohanty S, Sood S, Dhawan B, Das BK, Kapil A. Emerging resistance to carbapenems in a tertiary care hospital in north India. Indian J Med Res. 2006;124(1) :95–8.
19. Joseph NM, Bhanupriya B, Shewade DG, Harish BN. Relationship between antimicrobial consumption and the incidence of antimicrobial resistance in Klebsiella pneumoniae. Australas Med J. 2010;3(10):611–7.
20. Singhal A, Sharma R, Jain M, Vyas A. Emergence of carbapenem-resistant Klebsiella pneumoniae in neonatal intensive care unit: Epidemiology and molecular characterization. Indian Pediatr. 2019;56(4):283–7.
21. Kumarasamy KK, Toleman MA, Walsh TR, Bagaria J, Butt F, Balakrishnan R, et al. Emergence of a new antibiotic resistance mechanism in India, Pakistan, and the UK: A molecular, biological, and epidemiological study. Lancet Infect Dis. 2010;10(9):597–602.
22. Wattal C, Goel N, Oberoi JK, Raveendran R, Datta S, Prasad KJ. Surveillance of multidrug resistant organisms in tertiary care hospital in India. Indian J Med Microbiol. 2010;28(2):123–9.
23. Karaiskos I, Giamarellou H. Multidrug-resistant and extensively drug-resistant Klebsiella pneumoniae infections: Current opinion and future perspectives. Expert Opin Pharmacother. 2014;15(10):1351–70.
24. Logan LK, Weinstein RA. The epidemiology of carbapenem-resistant Enterobacteriaceae: The impact and evolution of a global menace. J Infect Dis. 2017;215 (suppl_1):S28–36.
25. World Health Organization (WHO). Global priority list of antibiotic-resistant bacteria to guide research, discovery, and development of new antibiotics. Geneva: WHO; 2017.
26. Indian Council of Medical Research (ICMR). Antimicrobial resistance surveillance network annual report. New Delhi: ICMR; 2022.