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PREVALENCE OF CARBAPENEM-RESISTANT KLEBSIELLA PNEUMONIAE CAUSING UTI AMONG PATIENTS ATTENDING J.L.N MEDICAL COLLEGE AND ASSOCIATED GROUP OF HOSPITALS, AJMER (RAJASTHAN).

Clinical Microbiology

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ABSTRACT

Background: Carbapenem-resistant Klebsiella pneumoniae has emerged as a significant cause of healthcare-associated urinary tract infections (UTIs).**AIM:** To determine the prevalence of carbapenem-resistant Klebsiella pneumoniae causing UTI and differentiate metallo beta lactamases from serine carbapenemses.**Methods:** The study was conducted in the Department of Microbiology, Jawaharlal Nehru Medical College, Ajmer (September 2023–August 2024). Urine samples were processed using standard microbiological methods. Carbapenem resistance was screened by Kirby–Bauer disk diffusion and confirmed by modified carbapenem inactivation method (mCIM) and EDTA-carbapenem inactivation method (eCIM).**Results:** Among 1321 positive cultures, 34 (2.57%) were CRE; K. pneumoniae accounted for 79.4%. Of 149 isolates, 27 (18.1%) were carbapenemase producers, predominantly serine carbapenemases. **Conclusion:** Carbapenem-resistant K. pneumoniae is present among UTI isolates in this setting, highlighting the need for continued antimicrobial resistance surveillance.

KEYWORDS

Klebsiella Pneumoniae, Carbapenem Resistance, **mCIM, eCIM,** Urinary Tract Infection.

INTRODUCTION

Klebsiella pneumoniae is the second most common Gram-negative bacterium implicated in UTIs, particularly in healthcare-associated settings, where it accounts for approximately 6-17% of infections[1]. Similar to *E. coli*, *K. pneumoniae* possesses a range of virulence factors that facilitate its survival and pathogenicity within the urinary tract. The bacterium's polysaccharide capsule plays a crucial role in evading the host's immune system by inhibiting phagocytosis and preventing the action of complement proteins[2]. Additionally, *K. pneumoniae* produces siderophores that enable it to acquire essential iron in the iron-limited environment of the urinary tract[3].

Carbapenem resistance often arises due to the production of carbapenemase enzymes, such as KPC (Klebsiella pneumoniae carbapenemase), NDM (New Delhi metallo-β-lactamase), OXA-48, and VIM (Verona integron-encoded metallo-β-lactamase)[4]. These enzymes break down carbapenems, rendering them ineffective. The spread of resistance genes occurs rapidly via horizontal gene transfer mechanisms, such as plasmids, complicating infection control efforts [5]. The increasing prevalence of these resistant strains has been reported worldwide, with significant regional variability[6].

In India, the burden of carbapenem-resistant *E. coli* and *K. pneumoniae* is particularly high, exacerbated by factors like high antibiotic consumption, over-the-counter drug availability, and inconsistent infection control measures [7]. Rajasthan, in particular, has witnessed a growing challenge with AMR, emphasizing the need for region-specific data to inform treatment and prevention strategies [8].

Understanding local resistance patterns is crucial for developing effective infection control strategies. Hospital-acquired infections caused by carbapenem-resistant *K. pneumoniae* often spread rapidly, particularly in settings with high patient density and frequent use of invasive medical devices. Infection control measures, such as hand hygiene, patient isolation, and environmental decontamination, are essential for preventing the spread of resistant organisms.

MATERIAL AND METHODS

This study was conducted in the Department of Microbiology, Jawaharlal Nehru Medical College, Ajmer (September 2023–August 2024), with institutional ethical approval. Urine samples obtained from various medical and surgical departments, ICU, IPD and OPD were included in the study. Samples were processed using standard microbiological methods. Isolates were screened for carbapenem resistance using Kirby–Bauer disk diffusion (CLSI 2023 guidelines using Meropenem 10µg disk. Isolates which showed inhibition zone diameter of ≤19mm were considered as screening test positive.

The modified carbapenems inactivation method was performed as confirmatory test for detection of carbapenems production in these isolates. Along with mCIM test, eCIM test was also be performed to differentiate metallo-beta lactamases from serine carbapenemes.

K. pneumoniae ATCCBAA1705 strain was used as positive control and K. pneumoniae ATCCBAA1706 as negative control in mCIM test.

INCLUSION CRITERIA:

- The patient must be ≥15 years.
- K. pneumoniae isolated from urine samples showing resistance to at least one carbapenem (imipenem/ meropenem) BY Kirby-Bauer disc DIFFUSION METHOD as per CLSI guidelines included in the study.

EXCLUSION CRITERIA :

- Patients with age < 15 years.
- K. pneumoniae isolated from urine samples that do not show resistance to any carbapenems were not included in this study.
- Duplicate isolates were collected from the same patients were considered a single isolate, excluded.
- Refusal to participate in the study.

Ethical Letter No. & Date of approval of plan in College: 2429/ACAD-III/MCA/2023/31-08-2023.

RESULTS

Out of 220 urine samples, 34 samples were confirmed as Carbapenem Resistant Enterobacteriaceae (CRE), with Klebsiella pneumoniae accounting for 27 cases (79.4%) and other CRE accounting for 7 cases (20.6%).

Out of a total of 220 patients, 142 are male, accounting for 64.5% of the sample, while 78 are female, representing 35.5%. This indicates that UTIs in this particular sample are more prevalent among males than females, which contrasts with general epidemiological trends where UTIs are typically more common in females.

Among the 220 patients, 122 (55.5%) are from rural areas, while 98 (44.5%) reside in urban settings. This indicates a slightly higher prevalence of UTIs among individuals from rural areas compared to their urban counterparts.

Of the total 220 patients, the highest proportion—80 patients (36.4%)—were admitted to the Urology Ward, followed closely by 76 patients (34.5%) in the Intensive Care Unit (ICU), and 64 patients (29.1%) in the Medicine Ward. This distribution suggests that UTIs are

being managed across a variety of clinical settings, with a particularly high concentration in the Urology Ward, likely due to the ward's specialized focus on urinary tract conditions.

A total of 220 UTI cases were analysed, revealing that Klebsiella pneumoniae was the most commonly isolated organism, accounting for 149 cases (67.7%). In contrast, Escherichia coli was identified in 71 cases, representing 32.3% of the total.

1. MCIM Test Results

Table 1. Distribution of mCIM Test Results-

Organism	mCIM Result	Frequency (n)	Percentage (%)
Other Isolates	Positive	7	9.9
	Negative	64	90.1
	Total	**71**	**100**
Klebsiella pneumoniae	Positive	27	18.1
	Negative	122	81.9
	Total	**149**	**100**

Chi-square (χ^2): 2.51
p-value: 0.113

Among the 149 K. pneumoniae isolates, 27 (18.1%) were mCIM positive and 122 (81.9%) were negative.

2. eCIM Test Results -

Table 2. Distribution of eCIM Test Results

Organism	Enzyme Type	Frequency (n)	Percentage (%)
Other Isolates	Metallo-β-lactamase	1	14.3
	Serine carbapenemase	6	85.7
	Total	**7**	**100**
Klebsiella pneumoniae	Metallo-β-lactamase	5	18.5
	Serine carbapenemase	22	81.5
	Total	**27**	**100**

Chi-square (χ^2): 2.51
p-value: 0.113

Similarly, of the 27 mCIM-positive K. pneumoniae isolates, 5 (18.5%) were MBL producers and 22 (81.5%) were serine carbapenemase producers.

DISCUSSION

Out of 1321 urine cultures that showed significant bacterial growth, 34 isolates were identified as CRE, with *Klebsiella pneumoniae* being the predominant organism, accounting for 79.4% of the isolates, followed by *Escherichia coli* at 20.6%. In our study conducted the prevalence of carbapenem-resistant Klebsiella pneumoniae among urine culture isolates was found to be 2.04%.

A closer examination of methodology and sample sources may explain the lower prevalence observed in this study. The present study included only urine samples collected from inpatient and outpatient departments and did not include samples from critically ill patients in intensive care units, where CRE prevalence is generally higher. Studies reporting higher prevalence often include ICU patients or isolates from invasive infections such as bloodstream infections, where exposure to invasive procedures, prolonged hospitalization, and broad-spectrum antibiotics increases the risk of CRE infections.

When compared to similar studies conducted across India and globally, the prevalence in our study appears to be relatively low. Datta et al[9]. (2012) reported a prevalence of 7.87%, while Jan et al[10]. (2016) reported 8%. Higher prevalence rates were also documented by Rao and Indumathi et al[11](2016) and Nair and Vaz et al[12](2013). Compared to these studies, the prevalence observed in our study (2.57%) is comparatively lower.

In the present study, 220 patients with positive urine cultures were evaluated. A notable finding was the male predominance among UTI patients, with 142 males (64.5%) and 78 females (35.5%). Although UTIs are generally more common in females, the higher proportion of males in the present study may be attributed to increased hospitalization, catheterization, and the presence of underlying comorbidities among male patients.

The mean age of UTI patients in our study was approximately 36.4 years, indicating a higher burden of infection among young to middle-aged adults. This age group often represents the most active population and may have increased exposure to healthcare settings and risk factors that predispose them to infection.

A slightly higher proportion of patients were from rural areas (55.5%) compared to urban areas (44.5%). This distribution may reflect differences in healthcare access, health-seeking behaviour, and antibiotic use patterns between rural and urban populations.

Understanding the antimicrobial susceptibility pattern of carbapenem-resistant isolates is critical in guiding effective treatment and minimizing therapeutic failure. In the present study, the isolates were subjected to antimicrobial susceptibility testing against commonly used antibiotics, revealing important trends in retained susceptibility among certain antibiotic classes.

In the present study, phenotypic detection of carbapenemase production was performed using the modified carbapenem inactivation method (mCIM). Among the CRE isolates, the majority were positive for mCIM, indicating carbapenemase production.

Further differentiation using the EDTA-carbapenem inactivation method (eCIM) demonstrated that the majority of isolates were serine carbapenemase producers, while a smaller proportion were identified as metallo-β-lactamase producers.

Identification of the type of carbapenemase is clinically important, as different enzymes exhibit varying susceptibility to β-lactamase inhibitors and may influence therapeutic decisions.

CONCLUSION

This study identified *Klebsiella pneumoniae* as the predominant uropathogen among culture-positive urinary tract infections in patients attending J.L.N. Medical College and associated hospitals, Ajmer. Among the isolates, a proportion demonstrated carbapenem resistance, confirming the presence of carbapenem-resistant *K. pneumoniae* in the study setting. Phenotypic characterization using mCIM and eCIM tests revealed that serine carbapenemases were more common than metallo-β-lactamases among the resistant isolates. These findings highlight the emergence of carbapenem resistance in uropathogenic *K. pneumoniae* and underscore the importance of continuous antimicrobial resistance surveillance, accurate laboratory detection, and implementation of appropriate infection control measures.

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