Section: Microbiology

Original Research Article

PREVALENCE OF MULTIDRUG RESISTANT URINARY ISOLATES OF ENTEROBACTER CLOACAE: A RETROSPECTIVE ANALYSIS AT TERTIARY CARE HOSPITAL, VADODARA

Sonal Lakum[1], Ritu M. Bhatt[2], Rohan Thakar[3], Mansi Pathak[4], Vaidehi Mehta[5]

[1]Associate Professor, Department of Microbiology, Parul Institute of Medical Sciences & Research (PIMSR), Parul University, Vadodara, Gujarat, India.
[2]Assistant Professor, Department of Microbiology, Parul Institute of Medical Sciences & Research (PIMSR), Parul University, Vadodara, Gujarat, India.
[3]Assistant Professor, Department of Microbiology, Banas Medical College & Research Institute (BMCRI), Palanpur, Gujarat, India
[4]Resident Doctor, Department of Microbiology, Parul Institute of Medical Sciences & Research (PIMSR), Parul University, Vadodara, Gujarat, India.
[5]Professor & Head, Department of Microbiology, Parul Institute of Medical Sciences & Research (PIMSR), Parul University, Vadodara, Gujarat, India.

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Corresponding Author:
Dr. Rohan Thakar,
Email: rohanthakar95@gmail.com

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ABSTRACT

Background: The aim is to determine the prevalence of *Enterobacter cloacae* among urine culture isolates from hospitalized patients in a tertiary care hospital and to evaluate its antimicrobial susceptibility pattern and multidrug resistance (MDR) profile. **Materials and Methods:** A retrospective observational study was conducted in the Microbiology section of the NABL-accredited Central Clinical Laboratory, Parul Sevashram Hospital, Vadodara, from January 2025 to June 2026. Urine specimens from hospitalized patients with suspected urinary tract infection were processed using standard microbiological techniques. *E. cloacae* isolates were identified by conventional biochemical methods and confirmed using the VITEK® 2 automated identification system. Antimicrobial susceptibility testing was performed using the VITEK® 2 system, and results were interpreted according to the Clinical and Laboratory Standards Institute (CLSI) 2025 guidelines. Multidrug resistance was defined as resistance to at least one antimicrobial agent in three or more antimicrobial classes. **Result:** During the study period, 8,663 urine specimens were processed, of which 1,777 (20.5%) showed significant bacterial growth. *Enterobacter cloacae* were isolated from 40 (2.25%) culture-positive urine specimens. Most isolates were recovered from male patients (65%) and catheterized urine samples (75%), with the highest frequency observed among patients aged 21–40 years (57.5%). High resistance rates were observed against amoxicillin-clavulanate (95%), cefixime (90%), ceftriaxone (75%), ceftazidime (75%), ciprofloxacin (67.5%), and piperacillin-tazobactam (67.5%). Resistance to ertapenem was 57.5%, while 57.5% of isolates fulfilled the criteria for multidrug resistance. **Conclusion:** *Enterobacter cloacae* represent an important multidrug-resistant uropathogen among hospitalized patients, particularly in catheter-associated urinary tract infections. The high prevalence of resistance to commonly prescribed antimicrobials underscore the need for continuous antimicrobial resistance surveillance, institution-specific antibiograms, strict infection prevention and control practices, and robust antimicrobial stewardship programmes to optimize empirical therapy and limit the emergence and dissemination of resistant strains.

INTRODUCTION

Urinary tract infections (UTIs) remain among the most common bacterial infections worldwide, affecting individuals of all age groups and geographic regions. They impose a substantial burden on healthcare systems due to their high incidence, frequent recurrence, and associated healthcare costs. If left untreated or inadequately managed, UTIs can lead to serious complications, including pyelonephritis, bacteraemia, and urosepsis, thereby representing a significant public health concern. Furthermore, evolving global epidemiological trends have highlighted the increasing contribution of

opportunistic and multidrug-resistant Gram-negative pathogens to UTIs, particularly in healthcare settings where extensive antibiotic use and inadequate infection prevention and control measures facilitate their emergence and spread.[1,2]

Among the expanding spectrum of uropathogens, Enterobacter cloacae have emerged as an important opportunistic pathogen implicated in both community-acquired and healthcare-associated urinary tract infections. It is capable of causing a wide range of clinical manifestations, including uncomplicated cystitis, catheter-associated urinary tract infections (CAUTIs), upper urinary tract infections, and severe urosepsis. The risk of infection is particularly high among immunocompromised individuals, patients with diabetes mellitus, those undergoing invasive urological procedures, and individuals requiring prolonged urinary catheterization.[3,4] The growing clinical importance of E. cloacae is attributed to its remarkable metabolic adaptability, ability to persist in diverse environmental conditions, and propensity to colonize medical devices and other abiotic surfaces within healthcare settings. These characteristics facilitate its persistence in hospitals and promote nosocomial transmission, making it an increasingly significant healthcare-associated pathogen.[5]

In recent years, *Enterobacter cloacae* have demonstrated a marked increase in resistance to multiple classes of antimicrobial agents, posing a major therapeutic challenge. This rising resistance is primarily attributed to the overexpression of chromosomal AmpC β-lactamases, acquisition of extended-spectrum β-lactamases (ESBLs), and, more recently, the emergence of carbapenemase-producing strains harbouring enzymes such as *Klebsiella pneumoniae* carbapenemase (KPC) and New Delhi metallo-β-lactamase (NDM).[6,7] These resistance mechanisms confer multidrug-resistant (MDR) phenotypes, resulting in reduced susceptibility to a broad range of β-lactam antibiotics, including third-generation cephalosporins. Consequently, carbapenems have often remained the last effective therapeutic option; however, the increasing prevalence of carbapenem-resistant *E. cloacae* further limits available treatment choices and represents a significant public health concern.

Although *Enterobacter cloacae* have gained recognition as an important healthcare-associated pathogen, comprehensive data on its antimicrobial susceptibility profile and evolving multidrug resistance patterns remain limited, particularly in developing countries. The increasing prevalence of β-lactamase-producing strains, including AmpC β-lactamase and extended-spectrum β-lactamase (ESBL) producers, poses a significant therapeutic challenge. Failure to detect these resistance mechanisms accurately and promptly may lead to inappropriate antimicrobial therapy, resulting in poor clinical outcomes and further selection of resistant strains.

The lack of region-specific surveillance data on *Enterobacter cloacae* has limited the development of effective antimicrobial stewardship strategies and infection prevention policies. Therefore, the present study was undertaken to determine the prevalence of *E. cloacae* in urine specimens from a tertiary care hospital and to evaluate its antimicrobial susceptibility pattern and multidrug resistance profile among hospitalized patients.

MATERIALS AND METHODS

This retrospective observational study was conducted in the Microbiology section of the NABL-accredited Central Clinical Laboratory (CCL) at the NABH-accredited Parul Sevashram Hospital, Vadodara, Gujarat, from January 1, 2025, to June 30, 2026, after obtaining approval from the Institutional Ethics Committee (ECR/702/Inst/GJ/2015/RR-21/11010).

During the 18-month study period, a total of **8663** urine samples were collected from hospitalized patients with clinical suspicion of urinary tract infection (UTI). Specimens were collected under strict aseptic precautions and transported promptly to the microbiology laboratory for processing. Patients with culture-confirmed *Enterobacter cloacae* isolated from urine were included in the study. The authors did not have direct contact with the patients during the study. Clinical and demographic data were retrieved from the clinical microbiology laboratory information management system (LIMS) for the purpose of data collection and analysis.

Urine specimens were cultured on MacConkey agar and nutrient agar using a calibrated 0.001 mL inoculating loop and incubated aerobically at 37°C for 18–24 hours. Significant bacteriuria was defined as a colony count of $\geq 10^5$ colony-forming units (CFU)/mL. Suspected Enterobacter isolates were identified by the presence of large, moist, lactose-fermenting colonies on MacConkey agar, followed by Gram staining, which demonstrated Gram-negative bacilli. Preliminary identification was based on standard biochemical tests, including oxidase, catalase, citrate utilization, indole production, urease activity, triple sugar iron (TSI) agar reaction, and motility. Isolates showing an oxidase-negative, indole-negative, citrate-positive, motile phenotype with variable urease activity and an acid slant/acid butt reaction without H_2S production on TSI agar were presumptively identified as *Enterobacter cloacae*. Final species identification was performed using the VITEK® 2 ((BioMérieux) automated system in accordance with the manufacturer's instructions, with routine calibration and quality control procedures to ensure the accuracy and reproducibility of the results.

Antimicrobial susceptibility testing (AST) of *Enterobacter cloacae* isolates was performed using the VITEK® 2 automated microbiology system. Minimum inhibitory concentrations (MICs) were determined for antibiotics representing major

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antimicrobial classes, including β-lactams, carbapenems, aminoglycosides, folate pathway inhibitors, fluoroquinolones, and tetracyclines. Susceptibility results were interpreted according to the Clinical and Laboratory Standards Institute (CLSI) 2025 guidelines. Multidrug resistance (MDR) was defined as resistance to at least one antimicrobial agent in three or more antimicrobial classes, in accordance with internationally accepted consensus criteria.

RESULTS

A total of 8,663 urine specimens were received in the Microbiology section during the study period, of which 1777 (20.5%) yielded significant bacterial growth. *Enterobacter cloacae* were isolated from 40 (2.25%) culture-positive urine specimens.

The distribution of *E. cloacae* isolates according to gender and type of urine specimen is presented in [Table 1]. Of the 40 patients, 26 (65%) were males and 14 (35%) were females. Catheterized urine specimens accounted for the majority of isolates (30/40, 75%), while 10 (25%) were obtained from non-catheterized urine samples.

The age-wise distribution of patients is illustrated in [Figure 1]. Patients were categorized into four age groups: <20 years, 21–40 years, 41–60 years, and >60 years. The highest number of *E. cloacae* isolates was observed in the 21–40-year age group (23/40, 57.5%).

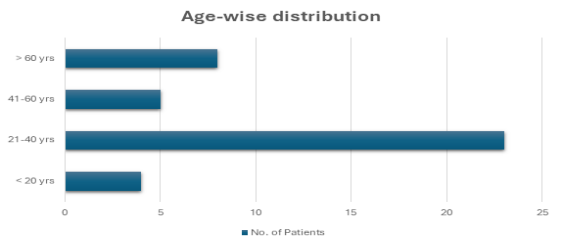

Figure 1: Age-wise Distribution of Patients

The antimicrobial susceptibility profile of *E. cloacae* isolates is summarized in Table II. High resistance rates were observed against amoxicillin-clavulanate (95%), cefixime (90%), ceftriaxone (75%), and ceftazidime (75%).

Table 1: Gender distribution and type of urine specimen among patients with *Enterobacter cloacae* urinary tract infection

Variable	Catheterized	Non-catheterized	Total
Male	20	6	26
Female	10	4	14
Total	30	10	40

Table 2: Antimicrobial susceptibility pattern of *Enterobacter cloacae* isolates (n = 40)

Antibiotic	Resistant, n (%)	Susceptible, n (%)
Cefixime	36 (90)	4 (10)
Ceftriaxone	30 (75)	10 (25)
Ceftazidime	30 (75)	10 (25)
Amoxicillin-Clavulanate	38 (95)	2 (5)
Piperacillin-Tazobactam	27 (67.5)	13 (32.5)
Ertapenem	23 (57.5)	17 (42.5)
Amikacin	22 (55)	18 (45)
Gentamicin	21 (52.5)	19 (47.5)
Fosfomycin	24 (60)	16 (40)
Ciprofloxacin	27 (67.5)	13 (32.5)
Ofloxacin	22 (55)	18 (45)
Norfloxacin	22 (55)	18 (45)
Nitrofurantoin	26 (65)	14 (35)
Trimethoprim-Sulfamethoxazole	20 (50)	20 (50)

The distribution of multidrug-resistant (MDR) and non-MDR *E. cloacae* isolates is depicted in [Figure 2]. Of the 40 isolates, 23 (57.5%) were classified as multidrug-resistant, while 17 (42.5%) were non-MDR.

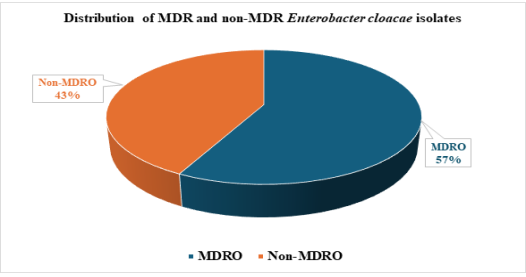

Figure 2: Distribution of multidrug-resistant (MDR) and non-MDR *Enterobacter cloacae* isolates

DISCUSSION

Enterobacter cloacae has emerged as an increasingly important opportunistic uropathogen, particularly in hospitalized patients, owing to its ability to acquire multiple antimicrobial resistance mechanisms and persist in healthcare environments. In the present study, *E. cloacae* was isolated from 40 (2.25%) of 1,777 culture-positive urine specimens. This finding is comparable to the study by Farooq et al., who reported a prevalence of 3.6% among urine samples from patients with UTI, highlighting that although *E. cloacae* is less common than *Escherichia coli*, it remains an important cause of complicated urinary tract infections.[8]

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The present study demonstrated a male predominance (65%), which is in agreement with the study by Hasan et al., where 64% of *E. cloacae* infections occurred in males.[9] In contrast, Bhalodia et al. reported a higher prevalence among females (59%), while Dehkordi et al. also emphasized that UTIs are generally more common in females because of anatomical predisposition.[10,11] These differences may be explained by variations in study populations, with our study and that of Hasan et al. including predominantly hospitalized patients, in whom catheterization, urological interventions, and underlying comorbidities are more frequent among males.

Urinary catheterization was identified as an important risk factor in the present study, with 75% of *E. cloacae* isolates recovered from catheterized urine specimens. Similar findings were reported by Bhalodia et al., who identified urinary catheterization as a statistically significant risk factor for *E. cloacae* urinary tract infection.[10] The ability of *E. cloacae* to form biofilms on indwelling urinary catheters facilitates persistent colonization, promotes horizontal transfer of resistance determinants, and contributes to recurrent healthcare-associated infections.

Most of our patients belonged to the 21–40-year age group (57.5%). This observation is consistent with the study by Bhalodia et al., in which the highest prevalence was also reported in the 21–40-year age group (38.4%).[10] However, Hasan et al. observed the highest burden of infection among patients aged ≥60 years, likely reflecting prolonged hospitalization and multiple comorbidities in their study population.[9] These variations suggest that the epidemiology of *E. cloacae* UTIs is influenced by local demographic characteristics and healthcare practices.[11]

The antimicrobial susceptibility profile in the present study revealed alarmingly high resistance to β-lactam antibiotics, particularly amoxicillin-clavulanate (95%), cefixime (90%), ceftriaxone (75%), and ceftazidime (75%). Similar findings have been reported by Elbehiry et al., who observed high resistance to ampicillin, amoxicillin-clavulanate, cephalothin, cefuroxime, and cefoxitin, while most isolates remained susceptible to carbapenems.[12] Likewise, Hasan et al. reported universal resistance to ampicillin, amoxicillin-clavulanate, cefazolin, and cefuroxime, with high resistance to ceftazidime (70%) and ceftriaxone (64%). Kadhim and Al-Hassani also demonstrated 100% resistance to amoxicillin-clavulanate and ceftazidime among urinary *E. cloacae* isolates.[13] These findings collectively reflect the widespread dissemination of AmpC β-lactamases, extended-spectrum β-lactamases (ESBLs), and other resistance determinants among E. cloacae.

Resistance to fluoroquinolones and aminoglycosides was also substantial in our study. Ciprofloxacin resistance was 67.5%, while resistance to amikacin and gentamicin was 55% and 52.5%, respectively. Similar trends have been observed in recent international studies, although Hasan et al. reported lower resistance to amikacin and preserved susceptibility to meropenem and ertapenem.[9] Qiu et al. further demonstrated that integron-positive *E. cloacae* isolates exhibited significantly higher resistance to ciprofloxacin, trimethoprim-sulfamethoxazole, aminoglycosides, and fluoroquinolones, highlighting the role of mobile genetic elements in dissemination of multidrug resistance.[14]

More than half (57.5%) of the isolates in the present study were multidrug resistant. This finding is lower than the MDR prevalence reported by Hasan et al. (86%) but comparable to the increasing trend observed in other hospital-based studies. Bhalodia et al. reported 135 MDR isolates among 195 *E. cloacae* isolates (69.2%), further emphasizing the growing burden of multidrug resistance in tertiary care hospitals.

The present study was limited by its single-centre retrospective design, relatively small sample size, and the lack of molecular characterization of resistance mechanisms. Future multicentre studies with larger cohorts and molecular analyses are needed to strengthen antimicrobial resistance surveillance and guide evidence-based stewardship practices.

CONCLUSION

The present study demonstrated a high prevalence of resistance to β-lactams, fluoroquinolones, and several other commonly used antibiotics, with more than half of the isolates exhibiting multidrug resistance. These findings highlight the need for continuous antimicrobial resistance surveillance, institution-specific antibiograms, strict infection prevention and control measures, and effective antimicrobial stewardship programmes to optimize empirical therapy and limit the spread of resistant strains.

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