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Prevalence, Microbiological Profile and Antimicrobial Resistance Pattern of Catheter-Associated Urinary Tract Infection in a Tertiary Care Centre

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Abstract

Background: Catheter-associated urinary tract infection (CAUTI) remains a major healthcare-associated infection because indwelling urinary catheters bypass natural host defences, provide a surface for microbial adherence and are frequently used in critically ill and comorbid patients. Surveillance definitions identify CAUTI in relation to an indwelling urinary catheter present for more than two consecutive days, and international guidance emphasises that catheter duration is a dominant risk factor for infection.[1] The present study was undertaken to assess CAUTI prevalence, bacterial aetiology, antimicrobial susceptibility and beta-lactamase-mediated resistance among catheterized adult patients at a tertiary care centre in Indore.

Methods: This cross-sectional study included 100 adult in-patients catheterized for more than 48 hours. Patients with urinary tract abnormalities were excluded. After institutional ethics committee approval and informed consent, catheter urine specimens were collected aseptically through the sampling port, transported in sterile containers and processed by direct Gram staining and semi-quantitative culture on blood agar and MacConkey agar. Bacterial isolates were identified by standard microbiological methods. Antimicrobial susceptibility testing was performed by modified Kirby–Bauer disc diffusion according to CLSI guidance. Extended-spectrum beta-lactamase (ESBL) production was detected by double-disc synergy testing, while metallo-beta-lactamase (MBL) production was detected by imipenem screening and imipenem–EDTA combined disc testing.

Results: Significant bacteriuria was detected in 19 of 100 catheterized patients, giving a CAUTI prevalence of 19%. The mean age was 61.19 ± 14.62 years, and most patients were male. Intensive care units contributed the largest share of catheterized participants, and diabetes mellitus was the commonest comorbidity. Escherichia coli was the predominant pathogen, accounting for 12 of 19 isolates (63.2%), followed by Klebsiella pneumoniae in 3 isolates (15.8%). One isolate each of Proteus mirabilis, Pseudomonas aeruginosa, Klebsiella oxytoca and Acinetobacter baumannii was recovered. All isolates were resistant to ampicillin and amoxicillin-clavulanic acid. High resistance was observed to ceftriaxone (89.5%), ceftazidime, ciprofloxacin and tetracycline (84.2% each), and cotrimoxazole (78.9%). ESBL was detected in 63.2% of isolates and MBL in 31.6%.

Conclusion: CAUTI in this tertiary care setting was characterized by predominance of Gram-negative bacilli, especially E. coli, and by high resistance to commonly used beta-lactams and fluoroquinolones. The high ESBL and MBL rates indicate the need for routine culture-guided therapy, local antibiogram use, catheter stewardship and infection-control measures to reduce unnecessary catheter exposure.

Keywords: catheter-associated urinary tract infection, Escherichia coli, ESBL, MBL, antimicrobial resistance, tertiary care hospital, Indore

Introduction

Catheter-associated urinary tract infection is one of the most frequent healthcare-associated infections and represents a persistent challenge in acute care hospitals. The urinary catheter is a useful clinical device for bladder drainage, urine output monitoring and perioperative management, yet its use creates a direct route for microorganisms to enter the urinary tract. The CDC notes that about 75% of urinary tract infections acquired in hospitals are associated with urinary catheters, and that 15%–25% of hospitalized patients receive urinary catheters during their stay.[2] In surveillance practice, CAUTI is defined as urinary tract infection in a patient with an indwelling urinary catheter in place for more than two consecutive days in an inpatient location on the date of event or the day before.[1] This definition is relevant to hospital laboratories and infection-control teams because it links diagnosis to device exposure rather than to bacteriuria alone.

The clinical importance of CAUTI arises from its frequency, its avoidability and its contribution to antibiotic use. Each additional day of catheterization increases the chance of bacteriuria and infection, and CDC surveillance guidance reports a 3%–7% daily increase in CAUTI risk while an indwelling catheter remains in place.[1] The catheter also changes the ecology of the urinary tract by introducing an artificial surface on which organisms can adhere and form biofilms. Reviews of CAUTI pathogenesis emphasize that E. coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Proteus mirabilis, Enterococcus faecalis, Staphylococcus aureus and Candida species are common CAUTI pathogens, while biofilms contribute to persistence and reduced antimicrobial responsiveness.[3] In India, the challenge is compounded by high antimicrobial pressure, variable catheter-care practices and increasing multidrug resistance among uropathogens.[4]

Antimicrobial resistance in CAUTI has direct consequences for empirical treatment. Gram-negative bacilli causing catheter-associated infection often express ESBLs, AmpC beta-lactamases, carbapenemases or MBLs, which restrict therapeutic options and increase reliance on reserve antibiotics. In addition, patients with CAUTI are commonly elderly, diabetic, critically ill or postoperative, and they often have repeated healthcare exposure. Therefore, institution-specific microbiological surveillance is necessary. A local antibiogram informs clinicians which agents are likely to fail, supports antimicrobial stewardship and reduces indiscriminate broad-spectrum antibiotic use.[5]

The present study was planned to evaluate CAUTI among catheterized adult patients at Index Medical College Hospital & Research Centre, Indore. The primary objectives were to estimate the prevalence of CAUTI, determine the bacterial profile of isolates and describe the antimicrobial susceptibility pattern. A further objective was to detect ESBL and MBL production among uropathogens because these resistance mechanisms are clinically important in tertiary care settings.

Materials and Methods

This cross-sectional study was conducted in the Department of Microbiology, Index Medical College Hospital & Research Centre, Indore, over a period of three years. The study population consisted of 100 adult in-patients above 18 years of age who had been catheterized for more than 48 hours. Patients with known urinary tract abnormalities were excluded. The study was performed after approval and clearance from the institutional ethics committee, and participants fulfilling inclusion criteria were enrolled after informed consent.

Catheter urine was collected using strict aseptic precautions. The catheter tubing was clamped above the sampling port to allow freshly voided urine to collect. The port and adjacent tubing were cleaned vigorously with 70% alcohol. Urine was aspirated using a sterile syringe while maintaining the integrity of the closed drainage system, and the specimen was transported in a sterile, wide-mouthed screw-capped container. This approach is important because breaking the closed system or collecting urine from the drainage bag can introduce contamination and mislead culture interpretation.[6]

Each specimen was examined macroscopically and microscopically. Direct Gram staining was performed to identify pus cells and bacteria. Semi-quantitative culture was carried out on blood agar and MacConkey agar. Plates were incubated aerobically at 37°C for 24 hours and examined for significant growth. Bacterial identification was performed using colony morphology, Gram reaction and standard biochemical tests described in diagnostic microbiology manuals.[6] Antimicrobial susceptibility testing was performed by modified Kirby–Bauer disc diffusion on Mueller–Hinton agar. Interpretation followed Clinical and Laboratory Standards Institute recommendations.[7]

The antibiotic panel included ampicillin, amoxicillin-clavulanic acid, ceftriaxone, ceftazidime, cefepime, aztreonam, ciprofloxacin, cotrimoxazole, tetracycline, nitrofurantoin, gentamicin, amikacin, piperacillin-tazobactam, imipenem and chloramphenicol, depending on organism applicability. ESBL production was tested by double-disc synergy using ceftazidime and ceftazidime-clavulanate discs. MBL production was screened among imipenem-resistant isolates and confirmed using an imipenem–EDTA combined disc method. Data were tabulated as frequencies and percentages, and associations between resistance mechanisms and antibiotic resistance were analysed in the source dataset.

Results

Among the 100 catheterized adult patients included in the study, the mean age was 61.19 ± 14.62 years. The 61–70-year age group contributed the largest proportion of participants, indicating that CAUTI risk in this sample was concentrated in older adults. Males constituted 67% and females 33% of the study population. The medical intensive care unit accounted for 48% of patients and the surgical intensive care unit for 23%, reflecting heavy catheter use in critical care. Diabetes mellitus was the most common comorbidity and was present in 41% of patients; hypertension was present in 17%.

Significant culture growth was obtained from 19 specimens, yielding a CAUTI prevalence of 19%. All isolates were bacterial Gram-negative bacilli. E. coli was the predominant isolate, accounting for 63.2% of culture-positive cases, followed by K. pneumoniae at 15.8%. Proteus mirabilis, P. aeruginosa, K.oxytoca and A. baumannii each accounted for 5.3%. This organism distribution is consistent with the broader literature that identifies Enterobacterales, especially E. coli and Klebsiella species, as frequent CAUTI pathogens.[3] Regional studies from India have also reported E. coli as a leading uropathogen, although the relative contribution of Klebsiella, Pseudomonas and non-fermenters vary between hospitals.[4]

Table 1: Different variables under the study.

Variable	Finding
Total catheterized adults studied	100
Culture-positive CAUTI cases	19
CAUTI prevalence	19%
Mean age	61.19 ± 14.62 years
Male participants	67%
Female participants	33%
Commonest clinical area	MICU, followed by SICU
Commonest comorbidity	Diabetes mellitus

The antimicrobial susceptibility profile showed extensive resistance to commonly used agents. All 19 isolates were resistant to ampicillin and amoxicillin-clavulanic acid. Resistance to ceftriaxone was 89.5%, while resistance to ceftazidime, ciprofloxacin and tetracycline was 84.2% each. Cotrimoxazole resistance was 78.9%, cefepime resistance was 73.7%, and aztreonam resistance was 63.2%. Resistance to piperacillin-tazobactam, gentamicin and imipenem was 57.9% each. Nitrofurantoin resistance was 52.6%, chloramphenicol resistance was 42.1%, and amikacin resistance was comparatively lower at 31.6%. These results suggest limited utility of older aminopenicillins, broad resistance to third-generation cephalosporins and reduced reliability of fluoroquinolone therapy for empirical CAUTI treatment in the institution.

Table:2- Overall Resistance Pattern of organism isolated from CAUTI cases:

Antibiotic	Resistance among isolates
Ampicillin	100%
Amoxicillin-clavulanic acid	100%
Ceftriaxone	89.5%
Ceftazidime	84.2%
Ciprofloxacin	84.2%
Tetracycline	84.2%
Cotrimoxazole	78.9%
Cefepime	73.7%
Aztreonam	63.2%
Piperacillin-tazobactam	57.9%
Gentamicin	57.9%
Imipenem	57.9%
Nitrofurantoin	52.6%
Chloramphenicol	42.1%
Amikacin	31.6%

ESBL production was detected in 12 of 19 isolates (63.2%). ESBL positivity was significantly associated with resistance to amikacin, aztreonam, cefepime and ciprofloxacin in the uploaded dataset. MBL production was detected in 6 isolates (31.6%) and showed significant association with imipenem and

nitrofurantoin resistance. These findings indicate that resistance was not limited to a single antimicrobial class but reflected complex multidrug resistance. The high prevalence of ESBL and MBL producers among CAUTI isolates is concerning because device-associated infection may serve as a reservoir for resistant organisms within wards and intensive care units.

Discussion

The 19% CAUTI prevalence observed in this study is clinically significant because the enrolled population consisted of catheterized patients exposed for more than 48 hours. International and national studies have reported variable CAUTI rates due to differences in definitions, catheter-days, sampling practices, patient acuity and infection-control interventions. [1,8] In the present study, intensive care units contributed the largest share of participants, and this is expected because critically ill patients often require urine output monitoring, fluid management and perioperative support. Older age and diabetes mellitus were prominent in the study population, both of which may increase susceptibility to infection through impaired immune response, glycosuria, comorbidity burden and prolonged hospital stay.

The predominance of E. coli is biologically plausible and consistent with the organism's established uropathogenic potential. E. coli possesses adhesins, fimbriae, iron acquisition systems, toxins and biofilm-forming capacity, allowing colonization of urinary epithelium and catheter surfaces.[9] Klebsiella species are also important because capsule formation, environmental persistence and beta-lactamase production enhance survival in healthcare environments.[10] Although Pseudomonas, Proteus and Acinetobacter were less frequent in the present sample, their detection is important because they are often associated with device colonization, intrinsic resistance and biofilm formation. Proteus mirabilis is particularly relevant in catheter-associated infection because urease activity may promote alkaline urine, crystalline biofilms and catheter encrustation.[11]

The resistance pattern has immediate therapeutic implications. Complete resistance to ampicillin and amoxicillin-clavulanic acid indicates that these agents should not be used empirically for suspected CAUTI in this setting. Very high resistance to ceftriaxone and ceftazidime reflects the burden of ESBL-producing Enterobacterales. Fluoroquinolone resistance of 84.2% is also important because ciprofloxacin is frequently used for urinary infections, yet empirical use in this setting would be associated with a high probability of failure. Amikacin showed the lowest resistance among tested drugs, but aminoglycoside use must be individualized because nephrotoxicity risk is relevant in elderly and critically ill patients. Imipenem resistance of 57.9% is alarming and may reflect carbapenemase or MBL production, prior carbapenem exposure or spread of resistant hospital clones.

The high ESBL prevalence demonstrates the need for routine screening and reporting. ESBL-producing organisms hydrolyse many penicillin and cephalosporins and are frequently co-resistant to non-beta-lactam agents. In this study, ESBL positivity was associated with resistance to aztreonam, cefepime, ciprofloxacin and amikacin, showing that resistance markers can predict broader treatment limitations. MBL-producing isolates are even more concerning because MBLs hydrolyse carbapenems and are not inhibited by conventional beta-lactamase inhibitors.[12] The association of MBL positivity with imipenem resistance supports the validity of phenotypic detection and highlights the need for infection-control alerts when carbapenem-resistant isolates are recovered.

The findings support three practical interventions. First, catheter stewardship should be strengthened. Catheters should be inserted only when clearly indicated, maintained with aseptic technique and removed as soon as clinically feasible. The CDC identifies prolonged catheter use as the most important CAUTI

risk factor, and surveillance guidance shows a daily increase in infection risk while a catheter remains in place. [1,2] Second, clinicians should avoid empirical antibiotics that are predictably ineffective according to local resistance data. Treatment should be guided by urine culture and susceptibility testing, particularly in patients with prior healthcare exposure or severe illness. Third, the microbiology laboratory should continue ESBL and MBL detection because resistance mechanism reporting helps clinicians select therapy and helps infection-control teams identify resistant-organism clusters.

The study has limitations. It included 100 catheterized patients and yielded 19 culture-positive cases, so subgroup comparisons by organism are limited. Nevertheless, the sample reflects the practical case mix encountered in a tertiary care microbiology laboratory, where catheter urine specimens are submitted from high-risk wards rather than from a uniform surveillance cohort. The findings are therefore especially useful for institutional decision-making, because they identify which drugs are least suitable for empirical therapy and which organisms should trigger early infection-control attention. The study used phenotypic methods for ESBL and MBL detection but did not include molecular confirmation. Catheter-days and standardized infection rates per 1000 catheter-days were not calculated in the extracted dataset, which limits comparison with NHSN-style surveillance. However, the study provides valuable local evidence because it combines clinical sampling, standard culture, antimicrobial susceptibility testing and resistance mechanism detection in a tertiary care population. It also demonstrates the importance of analysing CAUTI data separately from uncomplicated community-acquired UTI data. A pooled urine-culture antibiogram may underestimate resistance in catheterized and intensive-care patients, whereas a CAUTI-specific antibiogram can support more rational escalation and de-escalation. For example, the comparatively lower resistance to amikacin in the present dataset should not be interpreted as a universal recommendation for aminoglycoside use, but as evidence that drug selection must consider renal function, severity of illness, organism identity and susceptibility results. Similarly, the high imipenem resistance and MBL positivity argue against casual carbapenem escalation without laboratory confirmation.

Conclusion

This tertiary care study found a CAUTI prevalence of 19% among adult patients catheterized for more than 48 hours. E. coli was the leading pathogen, followed by K. pneumoniae, while other Gram-negative bacilli were less frequent. Resistance to ampicillin, amoxicillin-clavulanic acid, third-generation cephalosporins and ciprofloxacin was high. ESBL production was detected in nearly two-thirds of isolates and MBL production in nearly one-third. These results indicate that empirical therapy for CAUTI in this setting should be cautious, culture-guided and aligned with a regularly updated local antibiogram. Reducing catheter duration, maintaining aseptic catheter care and strengthening antimicrobial stewardship are essential to limit CAUTI burden and resistant uropathogen transmission.

References

1. Centers for Disease Control and Prevention. Urinary tract infection (catheter-associated urinary tract infection [CAUTI] and non-catheter-associated urinary tract infection [UTI]) events. NHSN Patient Safety Component Manual. Atlanta: CDC; 2026.
2. Centers for Disease Control and Prevention. Catheter-associated urinary tract infection (CAUTI) basics. Atlanta: CDC; 2025.
3. Tegegne DT, Abbott IJ, Poźniak B. Catheter-associated urinary tract infections: understanding the interplay between bacterial biofilm and antimicrobial resistance. Int J Mol Sci. 2025 Sept 20;26(18):9193.

4. Mohapatra S, Panigrahy R, Tak V, J. V. S, K. C. S, Chaudhuri S, et al. Prevalence and resistance pattern of uropathogens from community settings of different regions: an experience from India. Access Microbiol. 2022 Feb 9;4(2):000321.
5. Truong WR, Hidayat L, Bolaris MA, Nguyen L, Yamaki J. The antibiogram: key considerations for its development and utilization. JAC Antimicrob Resist. 2021 May 25;3(2):dlab060.
6. Forbes BA, Sahm DF, Weissfeld AS. Bailey & Scott's diagnostic microbiology. 13th ed. St. Louis: Mosby; 2013. p. 919–930.
7. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing: CLSI supplement M100S. Wayne (PA): Clinical and Laboratory Standards Institute; 2016. 256 p.
8. Mangukiya JD, Patel KD, Vegad MM. Study of incidence and risk factors of urinary tract infection in catheterised patients admitted at tertiary care hospital. International Journal of Research in Medical Sciences. 2015;3(12):3808–11.
9. Johnson JR. Virulence factors in Escherichia coli urinary tract infection. Clin Microbiol Rev. 1991 Jan;4(1):80–128.
10. Wang G, Zhao G, Chao X, Xie L, Wang H. The characteristic of virulence, biofilm and antibiotic resistance of Klebsiella pneumoniae. Int J Environ Res Public Health. 2020 Aug 28;17(17):6278.
11. Schaffer JN, Pearson MM. Proteus mirabilis and urinary tract infections. Microbiol Spectr. 2015 Oct;3(5):10.1128/microbiolspec.UTI-0017-2013.
12. Franklin C, Liolios L, Peleg AY. Phenotypic detection of carbapenem-susceptible metallo-beta-lactamase-producing Gram-negative bacilli in the clinical laboratory. J Clin Microbiol. 2006 Sept;44(9):3139–44.