Section: General Medicine

Original Research Article

CLINICO-MICROBIOLOGICAL PROFILE AND ANTIMICROBIAL RESISTANCE PATTERNS OF CATHETER-ASSOCIATED URINARY TRACT INFECTIONS IN HOSPITALIZED PATIENTS AT A TERTIARY CARE CENTRE

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ABSTRACT

Background: Catheter-associated urinary tract infection (CAUTI) is a common healthcare-associated infection among hospitalized patients and is frequently complicated by biofilm formation and antimicrobial resistance. Knowledge of the local clinical profile, causative microorganisms, and resistance patterns is essential for appropriate empirical treatment and infection-prevention planning.
Materials and Methods: This hospital-based observational cross-sectional study included 168 adults admitted to the medical wards and intensive care units of a tertiary care centre. Patients aged 18 years or older with an indwelling Foley catheter for at least 48 hours were enrolled. Clinical features, comorbidities, routine laboratory parameters, urine microscopy, culture findings, and antimicrobial susceptibility results were recorded. Significant microbial growth was defined as at least $\geq 10^5$ CFU/mL. Symptomatic CAUTI was classified according to the prespecified study criteria. Categorical variables were compared using the chi-square or Fisher's exact test, while continuous variables were compared using the Mann–Whitney U test. A p value below 0.05 was considered statistically significant.
Results: Of the 168 patients, 64 (38.1%) had positive urine cultures. Symptomatic CAUTI was identified in 34 (20.2%) patients, while 30 (17.9%) had catheter-associated asymptomatic bacteriuria or funguria. Culture positivity was not significantly associated with age, sex, or diabetes mellitus. Fever, burning micturition, dysuria, and suprapubic pain or tenderness were significantly associated with positive cultures, whereas turbid or dark urine was not. Gram-negative bacteria accounted for 64.1% of isolates, followed by fungi or yeasts (23.4%) and Gram-positive bacteria (12.5%).
Conclusion: CAUTI among hospitalized adults was associated with a diverse microbial spectrum and a substantial antimicrobial-resistance burden. Clinical features and routine laboratory parameters alone were insufficient for reliable diagnosis.
Keywords: Antimicrobial resistance; catheter-associated urinary tract infection; hospitalized adults; indwelling urinary catheter; urinary pathogens; urine culture.

INTRODUCTION

Healthcare-associated infections remain a major patient-safety concern because they increase morbidity, prolong hospitalization, raise treatment costs, and contribute to preventable deaths. They also increase the use of broad-spectrum antimicrobial agents and promote the selection and transmission of antimicrobial-resistant microorganisms within

healthcare facilities.[1] Among device-associated infections, catheter-associated urinary tract infection (CAUTI) is one of the most frequently encountered infections in hospitalized adults. It develops in a patient with an indwelling urinary catheter or shortly after catheter removal when compatible clinical features and microbiological evidence of urinary infection are present.[2] Although urinary catheterization is essential for selected clinical indications, unnecessary insertion and prolonged catheter use expose patients to avoidable infectious complications.

Indwelling urinary catheters are commonly used for accurate monitoring of urine output in critically ill patients, management of acute urinary retention, selected surgical procedures, assistance in wound healing, and provision of comfort during end-of-life care. However, a catheter bypasses normal host defence mechanisms and provides microorganisms with direct access to the urinary tract. Microorganisms may enter through the catheter lumen following contamination of the closed drainage system or migrate along the external catheter surface from the periurethral region. Once introduced, they adhere to the catheter and urothelial surfaces and form a biofilm composed of microbial cells embedded within an extracellular matrix.[3] Biofilm formation protects organisms from urinary flow, host immune responses, and antimicrobial activity. Consequently, catheter-associated bacteriuria becomes increasingly common with longer catheter duration, and established biofilms may persist despite antimicrobial therapy unless the catheter is removed or replaced.

The clinical presentation of CAUTI is variable and may include fever, suprapubic discomfort, costovertebral-angle pain or tenderness, acute haematuria, altered mental status in selected vulnerable patients, and systemic features of sepsis. Diagnosis is particularly difficult among critically ill or older hospitalized adults because symptoms may be nonspecific and bacteriuria or pyuria may occur without true symptomatic infection. Catheter-associated asymptomatic bacteriuria is common and should be distinguished from symptomatic CAUTI because unnecessary urine cultures and inappropriate treatment of colonization contribute to avoidable antimicrobial exposure.[4] Current recommendations therefore emphasize obtaining urine cultures only when there is a reasonable clinical suspicion of infection, collecting samples correctly, and interpreting microbiological findings together with the patient's signs and symptoms.

The microbiological profile of CAUTI is more diverse than that of uncomplicated community-acquired urinary tract infection. Gram-negative bacilli such as Escherichia coli, Klebsiellapneumoniae, Pseudomonas aeruginosa, Proteus species, Enterobacter species, and Acinetobacterbaumannii are frequently isolated. Gram-positive organisms, particularly Enterococcus faecalis and Enterococcus faecium, may also be responsible, while Candida species are often detected in patients with prolonged catheterization, critical illness, diabetes, previous antimicrobial exposure, or extended hospitalization.[5] The distribution of causative microorganisms can vary according to patient population, hospital unit, catheter duration, infection-control practices, and local antimicrobial-prescribing patterns. National surveillance data have also shown that the species distribution and resistance patterns of catheter-associated isolates may differ from those of non-catheter-associated urinary infections.[6]

Antimicrobial resistance has made the clinical management of CAUTI increasingly complex. Catheterized patients are frequently exposed to repeated courses of antibiotics and may remain hospitalized for prolonged periods, increasing their risk of colonization or infection with multidrug-resistant organisms. Extended-spectrum beta-lactamase-producing Enterobacterales, carbapenem-resistant Klebsiellapneumoniae and Acinetobacterbaumannii, fluoroquinolone-resistant Gram-negative bacilli, vancomycin-resistant enterococci, and multidrug-resistant Pseudomonas aeruginosa have all been reported in catheter-associated infections.[6,7] Indian multicentre surveillance has demonstrated a substantial burden of healthcare-associated urinary tract infections and clinically important resistance among urinary pathogens, emphasizing the need for improved microbiological surveillance and infection-prevention practices.[8] Recent intensive-care surveillance across Asian countries has similarly shown that CAUTI continues to occur despite being largely preventable and that catheter exposure and duration are important determinants of infection risk.[9]

Increasing resistance reduces the reliability of conventional empirical antimicrobial regimens and may result in delayed administration of active therapy, treatment failure, prolonged hospital stay, recurrence, sepsis, and increased mortality. At the same time, indiscriminate use of reserve drugs, including carbapenems, polymyxins, and newer beta-lactam–beta-lactamase inhibitor combinations, may further accelerate resistance. Culture and antimicrobial susceptibility testing are therefore essential for directing definitive therapy, supporting de-escalation, and preventing unnecessary exposure to broad-spectrum agents. Treatment decisions must also differentiate true infection from asymptomatic bacteriuria, for which antimicrobial therapy is generally not recommended in patients with indwelling urinary catheters unless a specific accepted indication is present.[10]

The World Health Organization has reported that antimicrobial resistance is increasing across common bacterial infections, including urinary tract infections, and has emphasized the importance of standardized laboratory surveillance to guide national and facility-level responses.[11] Nevertheless, resistance patterns are influenced

strongly by local antimicrobial use, infection-control performance, referral practices, and patient characteristics. Findings from one institution or geographic region cannot therefore be applied reliably to another hospital without local validation. Recent Indian evidence has demonstrated marked resistance among common CAUTI pathogens and considerable variation in the relative occurrence of Pseudomonas aeruginosa, Klebsiellapneumoniae, Escherichia coli, Acinetobacterbaumannii, enterococci, and fungal organisms.[12]

Regular assessment of the clinical characteristics, microbial spectrum, and antibiogram of CAUTI is therefore necessary for developing institution-specific empirical treatment policies, improving antimicrobial stewardship, and identifying high-risk patient groups. It also provides evidence for strengthening catheter-insertion protocols, daily assessment of catheter necessity, timely catheter removal, appropriate specimen collection, and adherence to infection-prevention bundles. Against this background, the present study was undertaken to determine the clinico-microbiological profile and antimicrobial resistance patterns of catheter-associated urinary tract infections among hospitalized adults at a tertiary care centre. The findings are expected to support early recognition, culture-directed management, rational antimicrobial use, and locally appropriate strategies for the prevention and control of CAUTI.

MATERIALS AND METHODS

Study design and setting: This hospital-based, observational cross-sectional study was conducted in the Department of General Medicine, Sri Aurobindo Medical College and Postgraduate Institute, Indore, Madhya Pradesh, India. Patients admitted to general medical wards and intensive care units were screened for eligibility. The study evaluated the clinical presentation, urine-culture profile, spectrum of isolated microorganisms, and antimicrobial resistance patterns among hospitalized adults with indwelling urinary catheters. The study was conducted over 18 months, from June 2024 to November 2025.

Study population and sampling: The study population comprised hospitalized adults who had an indwelling Foley catheter for at least 48 hours. Eligible participants were recruited using consecutive non-probability sampling until the required sample size was achieved.

Patients were included when they met all the following criteria:

1. Age of 18 years or older.
2. Presence of an indwelling Foley catheter for at least 48 hours.
3. Provision of written informed consent.

Patients were excluded when they had a suprapubic catheter or condom drainage, or when symptoms or a documented diagnosis of urinary tract infection were present before urinary catheterization.

Sample-size calculation: The minimum sample size was calculated using the single-population proportion formula:

$$n = \frac{Z^2 \times P(1-P)}{d^2}$$

where

- (Z = 1.96) at 5% level of significance
- (P = 12.5%), estimated Prevalence of CAUTI
- (D = 5%), allowable error.

The final study sample consisted of 168 eligible catheterized patients.

Operational definitions: A positive urine culture was defined as significant microbial growth of at least $\geq 10^5$ CFU/mL colony-forming units per millilitre of auropathogen.

For consistency with the prespecified thesis protocol, study-defined symptomatic CAUTI was diagnosed when a patient developed significant microbial growth after at least 48 hours of Foley catheterization together with one or more of the following documented clinical features:

- Fever above 38°C
- Dysuria
- Urinary urgency or frequency
- Suprapubic tenderness
- Turbid or dark urine
- Burning micturition

Catheter-associated asymptomatic bacteriuria or funguria was defined as significant microbial growth in a catheterized patient without any documented clinical feature attributed to urinary tract infection.

Participants were therefore categorized as:

1. Symptomatic study-defined CAUTI
2. Catheter-associated asymptomatic bacteriuria or funguria
3. Negative urine culture

This terminology is preferable to describing the thesis criteria as a "strict CDC/NHSN definition," because some of the symptoms used in the thesis and the inclusion of yeast-only cultures do not correspond completely with current NHSN surveillance criteria.

Clinical assessment and data collection: Data were collected using a predesigned structured case-record form. Demographic information included age and sex. Clinical information included the ward or intensive care setting, relevant comorbidities, particularly diabetes mellitus, duration of hospitalization, available information regarding the duration of catheterization, and symptoms suggestive of urinary tract infection.

All participants underwent a general physical examination and systemic clinical examination. The presence or absence of fever, dysuria, urinary urgency or frequency, suprapubic discomfort or tenderness, burning micturition, and turbid or dark urine was documented. Clinical findings were recorded before the urine-culture results were incorporated into the final classification.

Laboratory investigations: Baseline laboratory investigations were performed as part of routine clinical care. These included:

- Haemoglobin concentration
- Total leukocyte count
- Differential leukocyte count
- Blood urea
- Serum creatinine
- Random blood glucose
- Urine routine examination
- Urine microscopy
- Urine culture
- Antimicrobial susceptibility testing

Urine microscopy findings included the presence of pus cells, red blood cells, microorganisms and other abnormalities reported by the clinical laboratory. Laboratory measurements were subsequently compared between culture-positive and culture-negative groups.

Urine-specimen collection: Urine specimens were obtained aseptically from the designated sampling port of the indwelling Foley catheter. The catheter tubing was not disconnected from the closed drainage system, and specimens were not collected from the drainage bag.

Approximately 3 mL of urine was aspirated from the sampling port using a sterile syringe after following aseptic precautions. The urine was transferred into a sterile, labelled, leak-proof specimen container and transported promptly to the microbiology laboratory for processing. Samples were incubated at 35–37°C for approximately 18–24 hours.

Microbiological processing and organism identification: Urine specimens were cultured using the conventional quantitative or semiquantitative microbiological procedures routinely followed by the institutional laboratory. Growth of at least $\geq 10^5$ CFU/mL was considered significant according to the threshold prespecified in the study protocol.

Bacterial and fungal isolates were identified using colony morphology, Gram staining, conventional biochemical reactions, and automated identification methods where available. A urine culture with no significant microbial growth was classified as negative. Where fungal growth was identified, the isolate was reported to the species level when species-level identification was available.

The thesis did not report the precise culture media, calibrated-loop volume, automated identification platform, handling of mixed cultures, or quality-control organisms. These details should be added from the microbiology laboratory records before submission.

Outcome measures: The primary outcome was the proportion of enrolled catheterized patients who fulfilled the prespecified definition of symptomatic CAUTI.

Secondary outcomes were:

1. Overall urine-culture positivity.
2. Proportion of patients with catheter-associated asymptomatic bacteriuria or funguria.
3. Clinical features among catheterized patients.
4. Association of age, sex, diabetes mellitus and individual clinical features with urine-culture status.
5. Distribution of bacterial and fungal isolates.
6. Antimicrobial susceptibility and resistance patterns of the isolated microorganisms.
7. Comparison of routine laboratory parameters between culture-positive and culture-negative participants.

Because the thesis tables used culture positivity rather than symptomatic CAUTI as the grouping variable for most association analyses, culture status was retained as the exploratory binary outcome. Symptomatic CAUTI and asymptomatic bacteriuria or funguria were reported separately as descriptive outcomes. The thesis identified 64 culture-positive patients, including 34 with symptomatic infection and 30 with asymptomatic microbial growth.

Statistical analysis: Data were entered into Microsoft Excel 2010 and analysed using IBM SPSS Statistics, version 22.0. Data completeness and consistency were assessed before analysis.

Categorical variables were summarized using frequencies and percentages. Continuous variables were assessed for their distribution. Because most laboratory measurements were non-normally distributed, they were summarized using the median and interquartile range, represented by the 25th and 75th percentiles.

Associations between categorical variables and urine-culture status were evaluated using the Pearson chi-square test. Fisher's exact test was applied when one or more expected cell frequencies were below five. Continuous laboratory parameters were compared between culture-positive and culture-negative patients using the Mann–Whitney U test.

The proportions of culture positivity, symptomatic CAUTI and catheter-associated asymptomatic bacteriuria or funguria were reported with 95% confidence intervals. All statistical tests were two-sided, and a p value below 0.05 was considered statistically significant.

Ethical considerations: The study protocol was reviewed and approved by the Institutional Ethics Committee of Sri Aurobindo Institute of Medical Sciences, Indore, under approval number SAIMS/IRC/IEC/87/23, with the documented review dated 17 December 2024. Written informed consent was obtained from each participant or an authorized representative after explaining the purpose and procedures of the study. Patient identifiers were removed from the analytical dataset, and confidentiality was maintained throughout data collection, analysis and reporting. Participation did not result in additional research-related diagnostic expenses.

RESULTS

A total of 168 hospitalized adults with indwelling urinary catheters were included in the analysis.

Participants ranged from 19 to 94 years of age, with a mean age of 52.2 ± 18.0 years and a median age of 56 years. Most participants were male, and more than one-third were older than 60 years.

Table 1: Demographic characteristics and their association with urine-culture positivity

Characteristic	Total, n (%)	Culture positive, n (%)	Culture negative, n (%)	Test statistic	p value
Age group, years					
18–30	27 (16.1)	13 (48.1)	14 (51.9)	$\chi^2 = 4.711$	0.452
31–40	20 (11.9)	6 (30.0)	14 (70.0)		
41–50	21 (12.5)	7 (33.3)	14 (66.7)		
51–60	38 (22.6)	13 (34.2)	25 (65.8)		
61–70	37 (22.0)	12 (32.4)	25 (67.6)		
>70	25 (14.9)	13 (52.0)	12 (48.0)		
Sex					
Male	105 (62.5)	38 (36.2)	67 (63.8)	$\chi^2 = 0.431$	0.512
Female	63 (37.5)	26 (41.3)	37 (58.7)		
Diabetes mellitus					
Present	48 (28.6)	20 (41.7)	28 (58.3)	$\chi^2 = 0.363$	0.547
Absent	120 (71.4)	44 (36.7)	76 (63.3)		
Overall	168 (100.0)	64 (38.1)	104 (61.9)		

Values in the culture-positive and culture-negative columns are row percentages. Pearson's chi-square test was used. A p value below 0.05 was considered statistically significant.

The 51–60-year age group represented the largest proportion of participants, followed by the 61–70-year group. Culture positivity was numerically highest among patients older than 70 years and those aged 18–30 years. However, age group was not significantly associated with culture status. Culture positivity was also slightly higher among females and patients with diabetes mellitus, although neither association reached statistical significance.

Table 2: Urine-culture findings and study-defined CAUTI outcomes

Outcome	n	Percentage (%)	95% confidence interval or note
Total catheterized patients evaluated	168	100.0	—
Positive urine culture, $\geq 10^5$ CFU/mL	64	38.1	30.8–45.4
Study-defined symptomatic CAUTI	34	20.2	Positive culture with ≥1 compatible clinical feature
Catheter-associated asymptomatic bacteriuria or funguria	30	17.9	Positive culture without a documented compatible feature
Negative urine culture	104	61.9	—

Urine cultures were positive in 64 of the 168 patients, producing an overall culture-positivity proportion of 38.1% with a 95% confidence interval of 30.8%–45.4%. Study-defined symptomatic CAUTI was identified in 34 patients, whereas 30 patients had catheter-associated asymptomatic bacteriuria or funguria. Thus, 53.1% of culture-positive patients were symptomatic, while 46.9% had no documented compatible clinical feature.

At least one clinical feature considered compatible with CAUTI was documented in 62 patients. Fever was the most frequent feature, followed by turbid or dark-turbid urine and burning micturition.

Table 3: Clinical features and their association with urine-culture positivity

Clinical feature	All patients with feature, n (%)	Culture positive, n (%)	Culture negative, n (%)	Sensitivity (%)	Test statistic	p value
Fever >38°C	37 (22.0)	24 (37.5)	13 (12.5)	37.5	$\chi^2 = 14.419$	<0.001
Burning micturition	19 (11.3)	18 (28.1)	1 (1.0)	28.1	$\chi^2 = 29.144$	<0.001
Dysuria	10 (6.0)	9 (14.1)	1 (1.0)	14.1	Fisher's exact	<0.001
Suprapubic pain or tenderness	8 (4.8)	7 (10.9)	1 (1.0)	10.9	Fisher's exact	0.005
Turbid or dark-turbid urine	35 (20.8)	15 (23.4)	20 (19.2)	23.4	$\chi^2 = 0.425$	0.514
At least one compatible feature	62 (36.9)	—	—	—	—	—

Fever, burning micturition, dysuria and suprapubic pain or tenderness were significantly associated with culture positivity. Burning micturition demonstrated the strongest statistical association. Nevertheless, no individual clinical feature demonstrated high sensitivity. Fever, the most sensitive clinical indicator, was present in only 37.5% of culture-positive patients. Turbid or dark-turbid urine was not significantly associated with culture positivity.

Table 4: Comparison of laboratory parameters between culture-positive and culture-negative patients

Laboratory parameter	Culture positive, median (IQR)	Culture negative, median (IQR)	Mann–Whitney U	p value
Haemoglobin, g/dL	10.3 (8.5–12.3)	10.6 (9.1–12.2)	3158	0.581
Total leucocyte count, cells/mm³	13,465 (8,482.5–15,555.0)	11,120 (7,590.0–16,910.0)	3574	0.362
Blood urea, mg/dL	49.0 (27.0–102.8)	51.0 (28.0–104.2)	3270	0.850
Serum creatinine, mg/dL	1.0 (0.8–3.2)	1.4 (0.8–2.9)	3188	0.650
HbA1c, %	5.7 (5.2–6.6)	5.6 (4.8–6.3)	3608	0.362

Although the median total leucocyte count was higher in culture-positive patients, the difference was not statistically significant. Haemoglobin, blood urea, serum creatinine and HbA1c were also comparable between the two groups. None of the evaluated routine laboratory parameters significantly differentiated culture-positive from culture-negative patients.

A total of 64 microorganisms were recovered from the culture-positive specimens. Gram-negative bacteria accounted for 41 isolates, Gram-positive bacteria for eight isolates and yeasts for 15 isolates.

Table 5: Distribution of microorganisms isolated from culture-positive patients

Microorganism	Isolates, n	Percentage of positive cultures (%)	Microbial category
Escherichia coli	15	23.4	Gram-negative bacillus
Pseudomonas aeruginosa	14	21.9	Gram-negative bacillus
Klebsiella pneumoniae	8	12.5	Gram-negative bacillus
Enterobacter cloacae	1	1.6	Gram-negative bacillus
Acinetobacter baumannii	1	1.6	Gram-negative bacillus
Klebsiella aerogenes	1	1.6	Gram-negative bacillus
Pseudomonas putida	1	1.6	Gram-negative bacillus
Enterococcus faecalis	4	6.2	Gram-positive coccus
Enterococcus faecium	2	3.1	Gram-positive coccus
Enterococcus species	2	3.1	Gram-positive coccus
Candida krusei	6	9.4	Yeast
Candida tropicalis	3	4.7	Yeast
Candida guilliermondii	2	3.1	Yeast
Candida parapsilosis	2	3.1	Yeast
Candida albicans	1	1.6	Yeast
Unspecified Candida species	1	1.6	Yeast
Total	64	100.0	—

Distribution by broad microbial category

Category	n (%)
Gram-negative bacteria	41 (64.1)
Gram-positive bacteria	8 (12.5)
Fungi or yeasts	15 (23.4)
Total	64 (100.0)

Gram-negative bacilli were the predominant microbial group. E. coli was the most frequently isolated organism, followed closely by P. aeruginosa. Together, these two organisms accounted for 45.3% of all culture-positive specimens. K. pneumonia was the third most common Gram-negative isolate. Among Gram-positive organisms, E. faecalis predominated, while C. krusei was the most frequently isolated fungal species.

Table 6: Antimicrobial susceptibility profiles of the principal bacterial and fungal isolates

Panel A: Resistance among major Gram-negative bacterial isolates

Antimicrobial agent	E. coli (n=15), resistant n (%)	P. aeruginosa (n=14), resistant n (%)	K. pneumoniae (n=8), resistant n (%)
Ciprofloxacin	12 (80)	12 (86)	6 (75)
Levofloxacin	1 (7)	10 (71)	0
Ofloxacin	3 (20)	2 (14)	1 (12)
Ceftriaxone	13 (87)	1 (7)	4 (50)
Ceftazidime	3 (20)	11 (79)	1 (12)
Cefepime	10 (67)	7 (50)	6 (75)
Cefoperazone–sulbactam	8 (53)	9 (64)	6 (75)
Piperacillin–tazobactam	6 (40)	7 (50)	6 (75)
Amikacin	4 (27)	8 (57)	7 (88)
Gentamicin	4 (27)	2 (14)	2 (25)
Amoxicillin–clavulanate	11 (73)	0	7 (88)
Imipenem	7 (47)	9 (64)	6 (75)
Meropenem	7 (47)	9 (64)	7 (88)
Ertapenem	4 (27)	0	5 (62)
Colistin	3 (20)	6 (43)	0
Cotrimoxazole	9 (60)	1 (7)	4 (50)

Among E. coli, the highest resistance was observed against ceftriaxone, ciprofloxacin and amoxicillin–clavulanate. Fosfomycin showed activity against 13 of 14 isolates with reported results, while tigecycline was active against all 11 isolates for which a result was available. Among P. aeruginosa, resistance was particularly high against ciprofloxacin, ceftazidime, imipenem and meropenem. K. pneumoniae demonstrated high resistance to amikacin, amoxicillin–clavulanate, meropenem, imipenem, cefepime and piperacillin–tazobactam. No colistin resistance was recorded among the K. pneumoniae isolates.

Panel B: Susceptibility and resistance among Enterococcus isolates

Antimicrobial agent	E. faecalis (n=4)	E. faecium (n=2)	Other Enterococcus spp. (n=2)
Vancomycin	S:4 / R:0	S:1 / R:1	S:1 / R:1
Teicoplanin	S:4 / R:0	S:1 / R:1	S:1 / R:1
Linezolid	S:4 / R:0	S:1 / R:0	NT
Daptomycin	S:4 / R:0	NT	NT
Tigecycline	S:4 / R:0	S:2 / R:0	S:1 / R:1
Ciprofloxacin	S:1 / R:3	S:0 / R:2	S:0 / R:2
Levofloxacin	S:1 / R:3	S:0 / R:2	S:0 / R:2
Erythromycin	S:1 / R:2	S:0 / R:2	S:0 / R:2
Penicillin G	S:2 / R:2	S:0 / R:2	S:0 / R:2
Tetracycline	S:0 / R:4	S:0 / R:2	S:0 / R:2
Nitrofurantoin	S:2 / R:1	S:0 / R:2	S:0 / R:2
Gentamicin	NT	S:0 / R:2	NT

S, susceptible; R, resistant; NT, not tested or not reported.

All four E. faecalis isolates were susceptible to vancomycin, teicoplanin, linezolid, daptomycin and tigecycline. In contrast, resistance to fluoroquinolones and tetracycline was common. One of the two E. faecium isolates and one of the two unspecified Enterococcus isolates were resistant to vancomycin and teicoplanin.

Panel C: Antifungal susceptibility of the principal Candida species

Antifungal agent	C. krusei(n=6)	C. tropicalis(n=3)	C. guilliermondii(n=2)	C. parapsilosis(n=2)
Fluconazole	S:0 / R:6	S:3 / R:0	S:2 / R:0	S:2 / R:0
Voriconazole	S:6 / R:0	S:3 / R:0	S:2 / R:0	S:2 / R:0
Caspofungin	S:2 / R:3	S:3 / R:0	S:2 / R:0	S:2 / R:0
Micafungin	S:2 / R:2	S:3 / R:0	S:1 / R:0	S:2 / R:0
Amphotericin B	S:3 / R:2	S:3 / R:0	S:2 / R:0	S:2 / R:0
Flucytosine	NT	NT	NT	NT
Nystatin	S:1 / R:0	NT	NT	NT

S, susceptible; R, resistant; NT, not tested or not reported. The number of reported susceptible and resistant isolates does not equal the species total for some agent–organism combinations because susceptibility results were unavailable for certain isolates.

All six C. krusei isolates were resistant to fluconazole but susceptible to voriconazole. Variable results were observed for caspofungin, micafungin and amphotericin B. All tested C. tropicalis,C. guilliermondii and C. parapsilosis isolates were susceptible to fluconazole, voriconazole, caspofungin and amphotericin B. The single C. albicans isolate and the single unspecified Candida isolate were reported in the thesis as susceptible to all tested antifungal agents.

The study demonstrated an overall urine-culture positivity of 38.1% among catheterized adults, while study-defined symptomatic CAUTI occurred in 20.2%. Demographic characteristics and diabetes mellitus were not significantly associated with culture positivity. Burning micturition showed the strongest clinical association with a positive culture, but all individual clinical features had low sensitivity. Routine haematological, renal and glycaemic parameters did not significantly differ between culture-positive and culture-negative participants.

Gram-negative bacilli were the dominant isolates, with E. coli, P. aeruginosa and K. pneumoniae accounting for most bacterial cultures. Fungal isolates formed nearly one-quarter of the microbial spectrum. The principal Gram-negative organisms exhibited extensive resistance to fluoroquinolones, cephalosporins, beta-lactam–beta-lactamase inhibitor combinations and carbapenems. Vancomycin resistance was identified among some Enterococcus isolates, while C. krusei demonstrated complete resistance to fluconazole.

[Figure 1] presents the proportions of patients with negative cultures, study-defined symptomatic catheter-associated urinary tract infection and catheter-associated asymptomatic bacteriuria or funguria among the 168 participants.

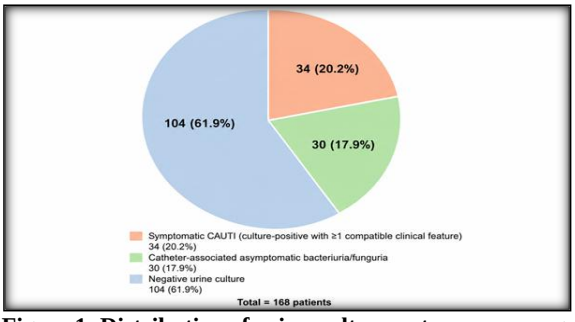

Figure 1: Distribution of urine-culture outcomes among hospitalized adults with indwelling urinary

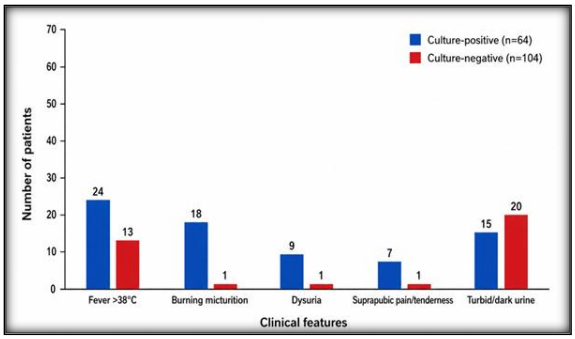

Figure 2: Clinical features among culture-positive and culture-negative catheterized patients

[Figure 2] compares fever, burning micturition, dysuria, suprapubic pain or tenderness and turbid or dark-turbid urine between the two culture groups.

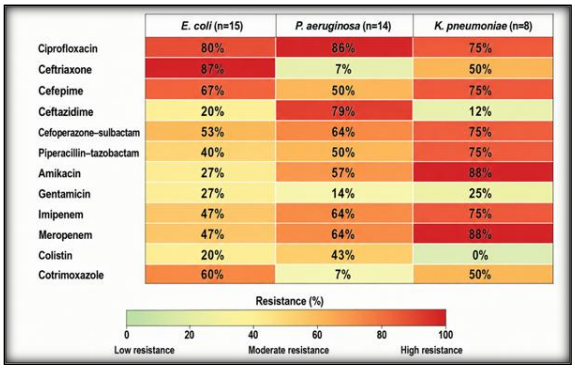

Figure 3: Antimicrobial resistance profile of the three principal Gram-negative CAUTI pathogens

[Figure 3] Theheatmap or grouped bar graph displays resistance to selected antimicrobial agents among Escherichia coli, Pseudomonas aeruginosa and Klebsiellapneumoniae isolates.

DISCUSSION

The present study evaluated 168 hospitalized adults with indwelling urinary catheters and demonstrated culture positivity in 38.1% of participants. Study-defined symptomatic catheter-associated urinary tract infection (CAUTI) was present in 20.2%, while 17.9% had catheter-associated asymptomatic bacteriuria or funguria. This distinction is clinically important because microbial growth in catheterized patients does not always represent symptomatic infection. Tambyah and Maki reported that catheter-associated bacteriuria was frequently asymptomatic, supporting the need to combine culture findings with compatible clinical features rather than treating every positive urine culture.[13] The relatively high culture positivity in the present study may reflect its tertiary-care setting, mixed ward and intensive-care population, severity of underlying illness, prior antimicrobial exposure, and catheter duration.

The study population showed a male predominance, with men comprising 62.5% of participants. However, culture positivity was slightly higher among women, and sex was not significantly associated with culture status. No significant association was found between age group or diabetes mellitus and culture positivity. These findings differ from the meta-analysis by Li et al., which identified female sex, diabetes, prolonged catheterization, previous catheterization, and longer hospital or intensive-care stay as CAUTI risk factors.[14] Letica-Kriegel et al. also identified catheter dwell time as a major determinant of infection after adjustment for demographic characteristics and comorbidities.[15] The lack of significant associations in the present study may reflect the modest sample size, unequal subgroup distribution, and absence of a multivariable model incorporating catheter days, illness severity, recent antibiotic exposure, and intensive-care stay.

Fever, burning micturition, dysuria, and suprapubic pain or tenderness were significantly associated with positive cultures. Burning micturition showed the strongest relationship, whereas turbid or dark urine was not significantly associated with culture positivity. Nevertheless, no individual symptom demonstrated high sensitivity; fever was present in only 37.5% of culture-positive patients. These findings highlight the diagnostic difficulty of CAUTI in hospitalized adults. Symptoms may be absent, masked by critical illness, or caused by another infection. Conversely, urine turbidity may result from sediment, crystalluria, haematuria, or colonization. Clinical assessment, correctly collected urine cultures, and exclusion of alternative infection sources should therefore be considered together.

Routine laboratory parameters, including haemoglobin, total leucocyte count, blood urea, serum creatinine, and glycated haemoglobin, did not differ significantly between culture-positive and culture-negative patients. Although the median leucocyte count was numerically higher in the culture-positive group, its limited discriminatory value indicates that systemic laboratory markers alone cannot confirm or exclude CAUTI. Hospitalized patients may have leukocytosis, renal dysfunction, or hyperglycaemia due to their underlying illness rather than urinary infection.

Gram-negative bacilli were predominant, accounting for 64.1% of isolates. Escherichia coliwas the most common organism, followed by Pseudomonas aeruginosa and Klebsiellapneumoniae. Niveditha et al. similarly identified E. coli as the principal CAUTI pathogen, followed by K. pneumoniae and P. aeruginosa.[16] Maharjan et al. also found E. coli to be predominant and demonstrated biofilm production among E. coli, Klebsiella, and Pseudomonas isolates.[17] Biofilm formation on catheter surfaces promotes persistent colonization and reduces antimicrobial penetration, helping explain recurrent infection and treatment difficulty.

Candida species accounted for 23.4% of positive cultures. Candida krusei was the leading fungal isolate, and non-albicans Candida species predominated. Rishpana and Kabbin reported candiduria in 26% of catheterized patients with nosocomial UTI and similarly observed

predominance of non-albicans Candida.[18] Keten et al. also found Candida species to be major pathogens among intensive-care patients.[19] However, candiduria frequently represents colonization, and antifungal treatment should generally be reserved for symptomatic infection or defined high-risk situations.[20] Complete fluconazole resistance among C. krusei isolates is consistent with the intrinsic resistance of this species. Preserved voriconazole activity and variable activity of echinocandins and amphotericin B support species-level identification and susceptibility-guided therapy.

The antimicrobial resistance profile was concerning. E. coli showed high resistance to ceftriaxone, ciprofloxacin, and amoxicillin–clavulanate. P. aeruginosa demonstrated marked resistance to ciprofloxacin, ceftazidime, and carbapenems, while K. pneumoniae showed high resistance to amikacin, meropenem, amoxicillin–clavulanate, and several beta-lactam–beta-lactamase inhibitor combinations. Carbapenem resistance considerably limits empirical options and may increase reliance on toxic or reserve agents. Keten et al. also documented reduced carbapenem susceptibility among non-fermenting Gram-negative bacilli and advised against empirical cephalosporin use where resistance was common.[19] These findings support regular institution-specific antibiograms, prompt de-escalation following culture results, and avoidance of unnecessary broad-spectrum therapy.

Among Enterococcus isolates, E. faecalis retained susceptibility to vancomycin, linezolid, daptomycin, and tigecycline, while resistance to fluoroquinolones and tetracycline was frequent. Vancomycin resistance among some E. faecium and unspecified Enterococcus isolates is important because therapeutic options become restricted. Overall, the study demonstrates a diverse microbial spectrum and substantial resistance burden. Daily assessment of catheter necessity, early removal, aseptic maintenance of the drainage system, culture-directed therapy, and antimicrobial stewardship are essential. The findings should be interpreted considering the single-centre design, small organism-specific groups, absence of catheter-day incidence rates, lack of multivariable adjustment, and incomplete susceptibility results for some organism–drug combinations.

CONCLUSION

Catheter-associated urinary tract infection remains an important clinical and microbiological concern among hospitalized adults. In the present study, urine-culture positivity was observed in 38.1% of 168 catheterized patients. Study-defined symptomatic CAUTI occurred in 20.2%, while 17.9% had catheter-associated asymptomatic bacteriuria or funguria. Age, sex, and diabetes mellitus were not significantly associated with culture positivity. Fever was the most frequently documented clinical feature, but its low sensitivity showed that it cannot be used alone to diagnose CAUTI. Burning micturition had the strongest association with a positive urine culture. Routine laboratory parameters, including total leucocyte count, serum creatinine, blood urea, haemoglobin, and HbA1c, did not significantly differ between culture-positive and culture-negative patients. These findings highlight the importance of correctly collected urine cultures and antimicrobial susceptibility testing for accurate diagnosis and treatment.

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