



CATHETER-ASSOCIATED URINARY TRACT INFECTIONS AND ANTIMICROBIAL SENSITIVITY PATTERN OF ORGANISMS IN INTENSIVE CARE UNIT PATIENTS AT A TERTIARY CARE HOSPITAL.

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Abstract:

Introduction: Catheter-associated urinary tract infections (CAUTIs) represent one of the leading types of hospital-acquired infections (HAIs) worldwide.^[1] Extended hospital stays, the use of invasive medical devices such as indwelling urinary catheters, and inappropriate or excessive administration of antimicrobial drugs are widely recognized as key contributors to the rising incidence of HAIs.^[2] Among critically ill patients with urinary catheters, infections including pyelonephritis, urethritis, cystitis, and prostatitis are frequently observed and pose significant clinical challenges. Gram-negative organisms are predominantly responsible for these infections in intensive care unit (ICU) settings.^[3]

Method: This investigation was designed as a cross-sectional, hospital-based study carried out in the Department of Microbiology at a tertiary care teaching hospital. Urine samples were collected from catheterized patients and cultured on CLED agar. Isolated colonies were identified and antibacterial susceptibility testing was performed by an automated method i.e. Vitek Compact.

Result: This investigation was conducted to assess the prevalence of CAUTI, identify the causative microorganisms, evaluate their antimicrobial susceptibility profiles, and analyse associated risk factors to support evidence-based prevention strategies. During the study period, 350 patients were admitted to the ICU, and healthcare-associated infections were documented in 105 cases. Of these, 35 patients were diagnosed specifically with CAUTI. Microbiological analysis revealed that *Klebsiella pneumoniae* (28.6%) was the most frequently isolated pathogen, followed by *Pseudomonas aeruginosa* (20%), *Proteus mirabilis* (14.3%), *Acinetobacter baumannii* (11.4%), *Enterococcus faecalis* (5.7%), and *Staphylococcus aureus* (5.7%). These findings highlight the predominance of Gram-negative bacteria in CAUTI cases within the ICU population.

Conclusion: Gram-negative bacteria predominated, with a high frequency of multidrug-resistant strains and significant beta-lactamase production.

These findings have important clinical implications. Continuous surveillance of local antibiogram patterns, strict adherence to catheter care protocols, early catheter removal, and implementation of robust antibiotic stewardship programs are essential to reduce CAUTI rates and combat antimicrobial resistance. The data generated may assist healthcare institutions in developing targeted infection prevention strategies and optimizing empirical treatment guidelines at a national level.

Keywords: catheter-associated urinary tract infection (CAUTI); *Klebsiella pneumoniae*; hospital acquired infections; *Proteus mirabilis*; *Pseudomonas aeruginosa*; antibiogram

Introduction:

Catheter-associated urinary tract infections (CAUTIs) represent one of the leading types of hospital-acquired infections (HAIs) worldwide.^[1] Extended hospital stays, the use of invasive medical devices such as indwelling urinary catheters, and inappropriate or excessive administration of antimicrobial drugs are widely recognized as key contributors to the rising incidence of HAIs.^[2] Among critically ill patients with urinary catheters, infections including pyelonephritis, urethritis, cystitis, and prostatitis are frequently observed and pose significant clinical challenges. Gram-negative organisms are predominantly responsible for these infections in intensive care unit (ICU) settings.^[3] During hospitalization, indwelling urethral catheters account for about 80% of urinary tract infections.^[4] Catheters may facilitate colonization of the urinary bladder due to poor catheter placement, prolonged catheterization, poor aseptic technique, poor hand hygiene, and poor asepsis of the urethral orifice opening. Hence, catheters are the most common source of infection^[5, 6] Overall, the study outlines the incidence of CAUTI in a tertiary care hospital and provides detailed insights into the microbial spectrum, associated risk determinants, and antibiotic resistance patterns. The data generated may serve as a foundation for developing and strengthening an institutional antibiotic stewardship program aimed at reducing infection rates and optimizing antimicrobial use across the healthcare facility.

1. Methods:

This investigation was designed as a cross-sectional, hospital-based study carried out in the Department of Microbiology at a tertiary care teaching hospital. Relevant clinical details were obtained from patients admitted to the Intensive Care Unit (ICU).

The study population comprised adult patients older than 20 years who were admitted to the ICU during the study period, had medical conditions including urinary tract infections (UTIs), and required urinary catheterization with a Foley catheter. Patients who demonstrated positive urine culture results prior to catheter insertion were excluded to avoid confounding pre-existing infections.

Written informed consent was obtained from all participants before enrolment. To maintain confidentiality, each participant was assigned a unique identification code, and all study-related records were anonymized. No personally identifiable information was accessed or documented. Comprehensive patient data were extracted from medical records, including demographic characteristics (age and sex), clinical presentation, reason and type of admission, associated risk factors, underlying comorbidities, indication for catheterization, antimicrobial susceptibility profile (antibiogram), and clinical outcomes related to catheter-associated urinary tract infection (CAUTI) management.

For microbiological analysis, approximately 10 mL of urine was aseptically aspirated from the catheter tubing using a sterile disposable syringe and transferred into a sterile universal container. Prior to sample collection, the aspiration port was disinfected with 70% ethanol to ensure aseptic conditions.^[7] The catheter tubing was temporarily clamped proximal to the urethral or suprapubic insertion site to obtain a fresh urine specimen. Samples were immediately transported to the microbiology laboratory in a temperature-controlled container to preserve specimen integrity.

Microscopic examination was initially performed using a direct wet mount preparation of uncentrifuged urine to assess the presence of pyuria and bacteriuria under high-power magnification. Subsequently, urine specimens were cultured quantitatively by inoculating them onto Cysteine-Lactose-Electrolyte-Deficient (CLED) agar plates using a calibrated disposable inoculating loop with a 3.26 mm internal diameter (delivering 0.001 mL of urine). The inoculated plates were kept in incubator at 37°C for 16–18 hours.^[8]

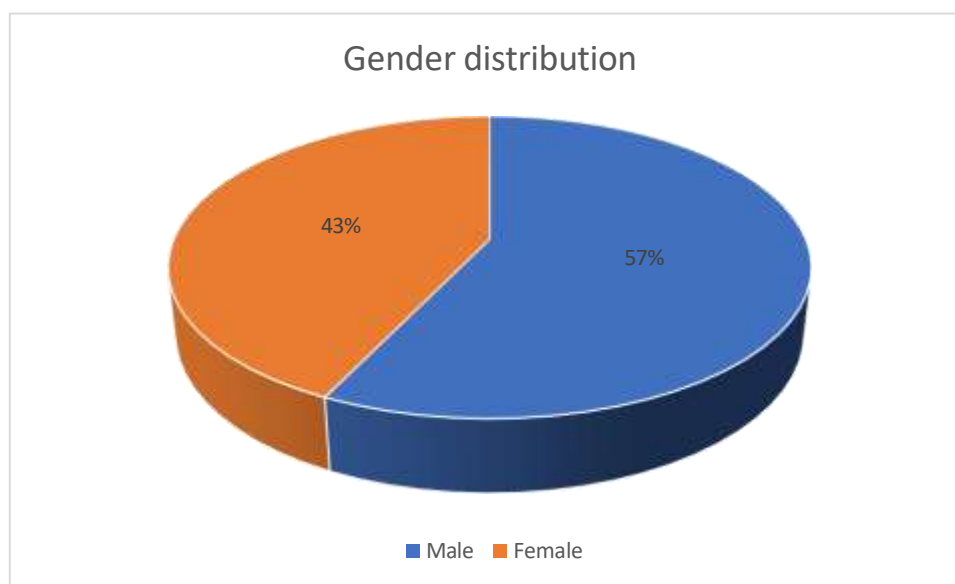
Following incubation, colony counts were determined using a digital colony counter. The number of colony-forming units (CFU) per millilitre was calculated based on the inoculum volume. For

example, the growth of 100 colonies from 0.001 mL of urine corresponded to 10^5 CFU/mL, which is considered indicative of significant bacteriuria. Samples demonstrating significant growth ($\geq 10^5$ CFU/mL) were further processed for organism identification to the species level using an automated identification system VITEK Compact (Biomerieux).^[8,9]

2. Result:

A total of 350 patients were admitted to the hospital's intensive care unit, of which HAI was reported in 105 patients. Among these, CAUTI was reported only in 35 patients.

Image 1 shows the gender distribution of case of CAUTI.



Significantly more male patients had CAUTI compared to female patients, with a ratio of 1.33 (20/15; **Figure 1**).

Table 1 shows age wise distribution of cases of CAUTI.

Age (Years)	Number of patients (n=35)	Percentage (%)
20-30	2	5.7
31-40	4	11.4
41-50	5	14.2
51-60	7	20
61-70	8	22.8
71-80	9	25.7

The most common age group seen with CAUTI infection was 70–80 years (n = 9, 25.7%), followed by 60–70 years (n = 8, 22.8%), and 50–60 years (n = 7, 20%), with the least common Age group being 20–30 years (n = 2, 5.7%).

Table 2 shows that most patients had urethral catheterization (25; 71.4%) with a few suprapubic catheterizations (10; 28.6%). The 16 Fr catheter size was the most common (n = 16, 45.7%), with 18 Fr being the least common size (n=8, 22.8%). Most of the patients with long-term indwelling urethral catheterization (IUC) had a significantly higher prevalence of CAUTI (19; 54.3%) than those with short-term IUC (6; 17.14%). Significantly, the patients with long-term IUC had a significantly higher prevalence of benign prostatic hyperplasia (BPH) (10; 28.6%) than the patients with short-term IUC.

Table 2. Clinical characteristics of patients with CAUTI in the study participants.

Patient Characteristics	Type of Catheter (n = 35)	Percentage (%)
Urethral type	25	71.4
Suprapubic type	10	28.6
Cather size (French size) Fr		
14	11	31.4
16	16	45.7
18	8	22.8
Duration of indwelling urethral catheterization (days)		
0-15	6	17.14
15-30	10	28.6
>30	19	54.3
Implication for catheterization		
Urine retention	8	22.9
Benign prostatic hyperplasia	10	28.6
Urethral stricture	8	22.9
Urinary incontinence	4	11.4
Others	5	14.3

Table 3 presents the symptoms that persisted in the study group, where fever was the most common symptom (n = 9, 25.7%), followed by flank pain (n = 8, 22.9%), urinary urgency (n = 5, 14.3%), and suprapubic pain (n = 4, 11.4%), and haematuria (n = 2, 5.7%) as the least recorded symptom.

Table 3. Rate and frequency of clinical symptoms in CAUTI patients.

Symptoms	Number of patients (n=35)	Percentage (%)
Fever	9	25.7
Flank Pain	8	22.9
Suprapubic tenderness	4	11.4
Fever with suprapubic pain	4	11.4
Dysuria	3	8.6
Urinary urgency	5	14.3
Haematuria	2	5.7

In this study, the most common bacterial species found associated with CAUTI *Klebsiella pneumoniae* (28.6%) was the predominant isolate, followed by *Pseudomonas aeruginosa* (20%), *Proteus mirabilis* (14.3%), *Escherichia coli* (14.3%), *Acinetobacter baumannii* (11.4%), *Enterococcus faecalis* (5.7%), and *Staphylococcus aureus* (5.7%),

Table 5. Rate of bacterial species identified from CAUTI patients

Bacteria	CAUTI	Percentage (%)
<i>Acinetobacter baumannii</i>	4	11.4
<i>Klebsiella pneumoniae</i>	10	28.6
<i>Proteus mirabilis</i>	5	14.3
<i>Pseudomonas aeruginosa</i>	7	20
<i>Escherichia coli</i>	5	14.3
<i>Enterococcus faecalis</i>	2	5.7
<i>Staphylococcus aureus</i>	2	5.7

Table 6. Antibigram pattern of *Klebsiella pneumoniae*, the predominant isolate recovered from CAUTI patients.

Antibiotics	Sensitive (n=10)	Sensitivity	Resistant (n=10)	Resistance (%)
Amikacin	4	40	6	60
Amoxicillin/Clavulanic Acid	4	40	6	60
Cefuroxime	3	30	7	70
Ceftriaxone	3	30	7	70
Ciprofloxacin	3	30	7	70
Norfloxacin	3	30	7	70
Ertapenem	6	60	4	40
Imipenem	6	60	4	40
Meropenem	6	60	4	40
Piperacillin/Tazobactam	4	40	6	60
Trimethoprim/Sulfamethoxazole	4	40	6	60
Nitrofurantoin	7	70	3	30
Colistin	10	100	0	0

Table 7. Antibigram pattern of remaining bacterial isolates from CAUTI patients.

Antibiotics	A.baumanii (n=4)	P.mirabilis (n=6)	P.aeruginosa (n=8)	E.coli (n=6)	E.faecalis (n=2)	S.aureus (n=2)
Amikacin	2	2	1	2	2	1
Amoxicillin/Clavulanic Acid	1	2	1	3	1	1
Cefuroxime	0	0	0	1	-	0
Ceftriaxone	1	1	0	1	-	0
Ciprofloxacin	1	0	0	1	1	0
Norfloxacin	1	0	0	1	1	0
Ertapenem	2	2	0	3	1	1
Imipenem	2	2	2	3	1	1
Meropenem	2	2	2	3	1	1
Piperacillin/Tazobactam	1	2	2	3	-	-
Trimethoprim/Sulfamethoxazole	2	1	1	2	-	1
Nitrofurantoin	2	-	2	4	2	1
Colistin	4	-	8	6	-	-
Vancomycin	-	-	-	-	2	2
Teicoplanin	-	-	-	-	2	2
Linezolid	-	-	-	-	2	2
Daptomycin	-	-	-	-	2	2

3. Discussion

Urinary tract infections (UTIs) remain among the most frequently encountered infections in clinical practice, affecting individuals across all age groups and both sexes. Persistent or recurrent infections may predispose patients to chronic complications and significantly impair quality of life. Beyond their clinical consequences, UTIs contribute substantially to healthcare expenditures and antibiotic consumption.^[10] Both community-acquired and healthcare-associated infections represent major public health challenges, particularly in intensive care settings where invasive procedures and immunosuppressive therapies are common.

In this investigation, 350 patients admitted to the intensive care unit (ICU) were evaluated. Healthcare-associated infections (HAIs) were identified in 105 patients (30%), while catheter-associated urinary tract infections (CAUTIs) accounted for 35 cases (33.33% of HAIs). The prevalence observed in our cohort exceeds rates reported by H. Bizuayehu et al. (21%) and Vinoth et al. (20%).^[11,12] Several contributing factors may explain this variation, including inappropriate antibiotic use, prolonged ICU stay, extremes of age, immunosuppressive therapy, and indwelling

urethral catheterization.

Advanced age emerged as a prominent risk factor in our study, with 25.7% (9/35) of CAUTI cases occurring among patients aged 60–80 years.^[13,14,15] Age-related physiological changes, reduced immunity, and comorbid conditions likely increase susceptibility in this population. A male predominance was observed (male-to-female ratio 1.33:1),^[16] consistent with some previous findings, although other investigations have reported higher vulnerability among females.^[17,18,19] The discrepancy in our study may be attributed to the lower proportion of female participants. Fever was the most frequent presenting symptom (25.7%), and a significant association between fever and CAUTI was noted, underscoring the importance of evaluating catheterized ICU patients with unexplained pyrexia.^[20]

Duration of catheterization was strongly associated with infection risk.^[21] Patients with prolonged indwelling urinary catheters (IUCs) were generally older, and many elderly male patients had underlying prostatic enlargement consistent with benign prostatic hyperplasia, predisposing them to urinary stasis and infection. Evidence consistently demonstrates that longer catheter dwell time increases bacterial colonization of the drainage system, facilitating ascending infection and biofilm formation. Removal of urinary catheters at the earliest appropriate time has been shown to significantly reduce CAUTI incidence.^[22] Studies indicate that the risk of infection increases progressively with each additional day of catheterization, and near-universal colonization can occur after extended durations. Catheter size may also influence infection risk. In our study, the 16 Fr catheter was most frequently used. Clinical guidelines recommend using the smallest suitable catheter size to minimize urethral trauma, optimize drainage, and reduce complications such as bladder spasms and peri-urethral gland obstruction, which may predispose patients to infection.^[23]

The prevalence of CAUTI in this study was higher than that reported by Podkovik et al. (8.5%) and Getliffe et al. (4.76%).^[24,25] All CAUTI cases identified were bacterial in origin. Of the 35 isolates, 88.6% were Gram-negative organisms and 11.4% were Gram-positive organisms. Among Gram-negative bacteria, *Klebsiella pneumoniae* was the predominant pathogen (28.6%), followed by *Pseudomonas aeruginosa* (20%), *Proteus mirabilis* (14.3%), and *Escherichia coli* (14.3%). Among Gram-positive isolates, *Enterococcus faecalis* and *Staphylococcus aureus* were identified. While many studies report *E. coli* as the leading CAUTI pathogen, our findings demonstrated a predominance of *K. pneumoniae*, highlighting regional variability in microbial profiles.^[26,27,28] Although fungal pathogens such as *Candida* species are not consistently classified under CAUTI definitions by the CDC, their role in catheterized patients should not be underestimated.

Antimicrobial resistance patterns observed in this study are concerning. Gram-negative isolates demonstrated substantial variability in susceptibility. *K. pneumoniae* exhibited high resistance rates to cefuroxime, ceftriaxone, and ciprofloxacin (70%), as well as notable resistance to amikacin, amoxicillin/ clavulanic acid, piperacillin/ tazobactam, and trimethoprim/sulfamethoxazole (60%). However, relatively higher sensitivity was observed for nitrofurantoin (70%), imipenem (60%), and meropenem (60%).^[29] *P. aeruginosa* and *E. coli* showed complete sensitivity to colistin. The high resistance rate to ciprofloxacin (82.9%) suggests that it may no longer be suitable as an empirical first-line therapy in our setting.^[30]

A substantial proportion of Gram-negative isolates were identified as extended-spectrum beta-lactamase (ESBL) producers (80%), AmpC beta-lactamase producers (65.7%), and carbapenemase producers (54.3%).^[31] These resistance mechanisms significantly limit therapeutic options, often necessitating the use of carbapenems, colistin, or polymyxin B. The emergence and dissemination of multidrug-resistant (MDR) organisms, particularly among Enterobacteriaceae, are facilitated by plasmid-mediated gene transfer and selective antibiotic pressure. MDR infections are more prevalent in healthcare-associated settings and represent a growing global threat to patient safety.

4. Conclusions

This study determined the incidence of catheter-associated urinary tract infections in ICU patients and identified key risk factors, including advanced age, prolonged catheterization, and antimicrobial

misuse. Gram-negative bacteria predominated, with a high frequency of multidrug-resistant strains and significant beta-lactamase production.

These findings have important clinical implications. Continuous surveillance of local antibiogram patterns, strict adherence to catheter care protocols, early catheter removal, and implementation of robust antibiotic stewardship programs are essential to reduce CAUTI rates and combat antimicrobial resistance. The data generated may assist healthcare institutions in developing targeted infection prevention strategies and optimizing empirical treatment guidelines at a national level.

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