ORIGINAL ARTICLE

Incidence Risk Factors and Drug Resistance Patterns of Bacterial Isolates in Patients with Catheter-associated Urinary Tract Infections

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Abstract

Introduction: Catheter-associated urinary tract infections (CAUTIs) account for 80% of nosocomial UTIs and 40% of hospital-acquired infections, making them the most common healthcare-associated infections globally. Despite the rise of quinolone-resistant *Escherichia coli* and extended-spectrum β-lactamase-producing gram-negative bacteria, fluoroquinolones remain a common empirical treatment. Understanding antimicrobial resistance (AMR) associated with CAUTIs is critical.

Methods: A prospective observational study was conducted from November 2023 to July 2024 at Deenanath Mangeshkar Hospital, Maharashtra, India. The study included catheterized patients in the intensive care unit (ICU) with a duration of over 48 hours showing UTI symptoms, including fever, suprapubic discomfort, urgency, or dysuria. Among 80 patients (mean age 56.75 ± 23.65 years; 53% male), bacterial isolates, resistance patterns, and risk factors were analyzed.

Results: Catheter-associated UTIs developed in 59 patients (73.75% prevalence; 83.1 per 1,000 catheter days). Patients aged over 60, hospitalized for more than 10 days, or with comorbidities like diabetes (51.3%), hypertension (HTN) (37.5%), or chronic kidney disease (10%) were at higher risk. *Escherichia coli* and *Klebsiella pneumoniae* were the most common pathogens (34.14%), with gram-negative bacilli constituting 84.74% of isolates. *Candida* species, particularly *C. tropicalis* (34.78%) and *C. auris* (26%), were also significant.

Conclusion: This study identifies *E. coli*, *K. pneumoniae*, and *Candida* species as major CAUTI pathogens, with substantial multidrug resistance among gram-negative bacteria. Regular AMR surveillance and targeted infection control strategies are essential to combat CAUTI-related challenges and improve clinical outcomes.

Keywords: Antimicrobial resistance, Healthcare-associated infections, Nosocomial infections, Observational study.

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Introduction

With a frequency of 1.4–1.7/1,000 catheter days in hospitalized patients in medical and surgical wards, catheter-associated urinary tract infections (CAUTI) are the most prevalent cause of hospital-acquired infections. Despite this, acutely unwell individuals frequently go undiagnosed.[1] Worldwide, CAUTIs are the most common infections linked to healthcare. They are responsible for 40% of all hospital-acquired infections and 80% of nosocomial urinary tract infections (UTIs).[2] The CAUTIs are considered complicated UTIs treated with fluoroquinolones empirically. Over the years, there has been a rise in quinolone-resistant *Escherichia coli* and gram-negative bacteria producing extended-spectrum β-lactamases. These changes complicate the selection of optimal empiric therapy for clinicians. Therefore, it is crucial to recognize the current scenario of antimicrobial resistance (AMR) associated with CAUTIs.[3]

Indwelling catheters are the main source of CAUTIs, according to the Centers for Disease Control and Prevention (CDC). A UTI is defined by the CDC and the National Healthcare Safety Network (NHSN) as an infection brought on by a catheter implanted for at least 2 days in a row. Patients must exhibit at least one of the following symptoms: fever (≥38.0°C), suprapubic tenderness, or costovertebral angle pain or tenderness. Antibiotic usage for asymptomatic individuals with positive urine cultures has remained constant despite revisions to the NHSN and CAUTI criteria.

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The incidence of CAUTIs is greatly affected by variables such as the length of catheterization, aseptic insertion methods, and urine bag management. Serious side effects from uncontrolled CAUTIs, such as meningitis, cystitis, pyelonephritis, and prostatitis, can lengthen hospital stays and raise mortality, healthcare expenses, and antibiotic resistance.[4]

During catheter insertion, through the lumen of the catheter, or around the catheter's exterior, bacteria may enter the bladder. *Escherichia coli*, *Klebsiella* species, *Proteus* species, *Enterococcus* species, *Pseudomonas* species, and *Enterobacter* species are the most frequent pathogens. There is still a notable rate of CAUTI per 1,000 days of catheter use in critically sick patients who have been in the intensive care unit (ICU) for longer than 48 hours.[5]

It is essential to track antibiotic resistance patterns in the bacteria causing CAUTIs in order to help medical professionals make well-informed decisions about patient management. For Deenanath Mangeshkar Hospital and Research Center (DMHRC), however, there is not enough information. Thus, our goal was to assess the antibiotic resistance patterns in the isolated bacteria causing CAUTIs in the ICUs and other departments at DMHRC in Maharashtra, India.

Methods

Study Design, Setting, and Population

The CDC states that a patient is diagnosed with symptomatic CAUTI if they have significant bacteriuria (≥10^5 colony-forming units (CFU)/mL), an indwelling urethral catheter that has been in place for more than 2 days, and at least two symptoms of an acute UTI (fever, suprapubic tenderness, costovertebral angle pain or tenderness, urinary urgency, frequency, or dysuria). Patients who were (a) younger than 18 years old, (b) had a recent UTI history (within the last 6 months), (c) being pregnant or breastfeeding, (d) taking immunosuppressive medications or antimicrobial treatment for UTI (within 2 weeks), (e) had a substantial bacterial count and a positive urine culture on the day of catheter insertion, (f) catheterized outside of the hospital, (g) unconscious or cognitively impaired, (h) catheterized with a catheter other than a Foley catheter, (i) had polymicrobial growth in cultures, or (j) were discharged or transferred to another hospital while the catheter was in place.

Collection of Data and Exploration

A carefully thought-out and validated patient data collecting form was used to gather sociodemographic information from hospital medical records. Medical information on patients, such as comorbidities, admission reasons, ward, length of hospital stay, and length of catheterization**.** From their medical records, the site of the catheter implantation and the reasons for catheterization were obtained. Every patient had a clinical examination with an emphasis on symptoms, including fever, discomfort or pain in the suprapubic area, pain or tenderness in the costovertebral angle, dysuria, and frequent or urgent urination. The research included patients with at least two UTI symptoms (fever, suprapubic discomfort, costovertebral angle pain or tenderness, urine urgency, and urinary frequency) and those who had been catheterized for more than 48 hours.

Urine samples were taken from the recently replaced catheter as soon as possible before beginning antimicrobial medication in patients who had indwelling catheters for more than 7 days. These samples were sent right away for examination to the DMHRC Microbiology Laboratory. A pure culture was considered to have significant bacteriuria if its concentration was ≥105 CFU/mL. Because the less numerous organism was unlikely to be causing illness, only the dominant organism was subcultured in cultures with two species. Both organisms were subcultured if their concentrations were more than 10,000 CFU/mL. Even with low colony counts (<10,000 CFU/mL), the same organism was considered harmful if it was frequently observed in several urine cultures. Biochemical testing and colony morphology were used to further identify each isolate.

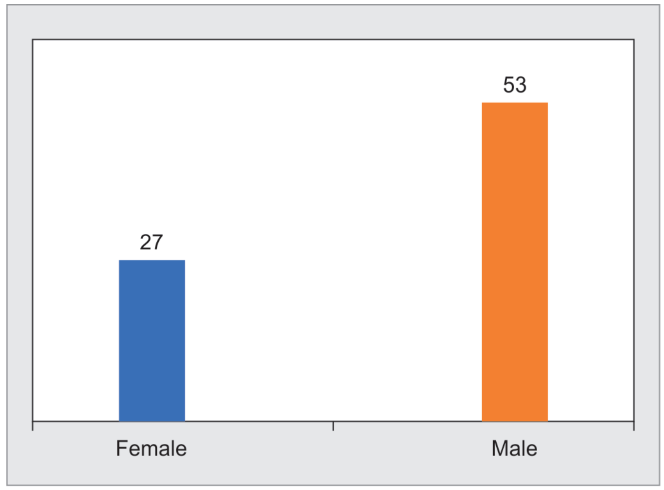

Fig. 1: Gender ratio

Reference

The Deenanath Mangeshkar Hospital and Research Center's Institutional Ethics Committee authorized the study protocol (protocol code PharmD_2023_Nov_BP_16). Consent forms for participants were not required because the study included patient data from both paper and electronic records. Using file numbers (MRD No.), all patient data was handled anonymously during the study and kept safe in protected software.

Statistical Analysis

The microbiology lab documented MDR microorganisms and their resistance patterns based on antibiotic susceptibility tests. The study patients' weight (kg) and age (years) were used to calculate the means and percentages. Drug resistance and pathogen differences were analyzed using a Chi-squared test (χ^2).

Results

Initial Sociodemographic and Clinical Characteristics

This research comprised 80 hospitalized patients who had urinary catheters for more than 2 days. Males comprised 53% of the individuals, with a 1:2 male-to-female ratio (Fig. 1). The average age was 56.75 ± 23.65 years (Fig. 2). The participants had catheterization for a total of 710 days, that ranged from 2 to 34 days, with an average length of 8.55 ± 6.11 days (Table 1).

CAUTI Incidence, Prevalence and Risk Factors

The total incidence rate of CAUTI was found to be 77.12%, and overall prevalence rate was 73.75%, with 59 out of 80 catheterized patients having CAUTIs. About 83.1 symptomatic CAUTIs were reported for every 1,000 catheter days. The age-group over 60 years, people admitted to the hospital for more than 10 days, and patients with underlying conditions had highest rates of CAUTIs, out of which bacterial count was found to be 39/80 (48.75%), with count to be 20/80 (25%).

Concerning risk concerns, such as placing a catheter outside of an operating room and requiring a lengthy catheterization (7 days), 37.5% had hypertension (HTN), 51.3% had diabetes mellitus (DM), 10% had chronic kidney disease (CKD), 5% had pyelonephritis, and 1.3% had renal calculus (Fig. 3). The odds of CAUTI occurrence were highest for patients with CKD (odds ratio of 7.0), followed by those with HTN (odds ratio of 3.29) and DM (odds ratio of 1.73). Pyelonephritis had an odds ratio of 1.0, indicating no increased risk, suggesting no occurrences of CAUTI in this group (Table 1).

The Variety of Bacteria that were Isolated from CAUTI Patients

Out of 80 patients, 59 bacterial isolates from eight distinct genera were obtained (Fig. 4). *Escherichia coli* and *K. pneumoniae* were the most often isolated organisms among the 59 isolates, accounting

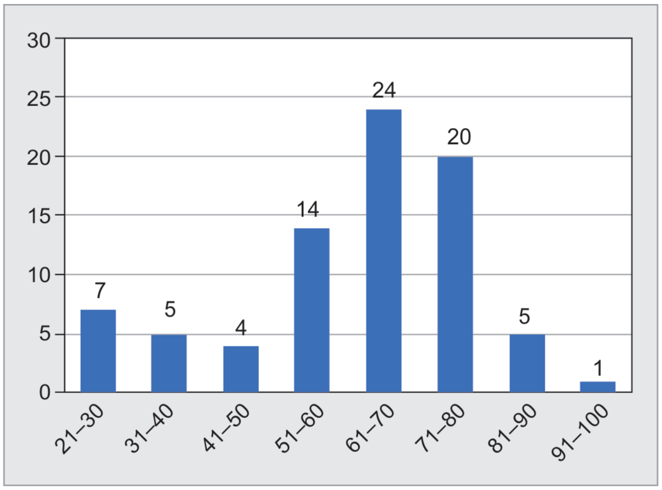

Fig. 2: Age-group

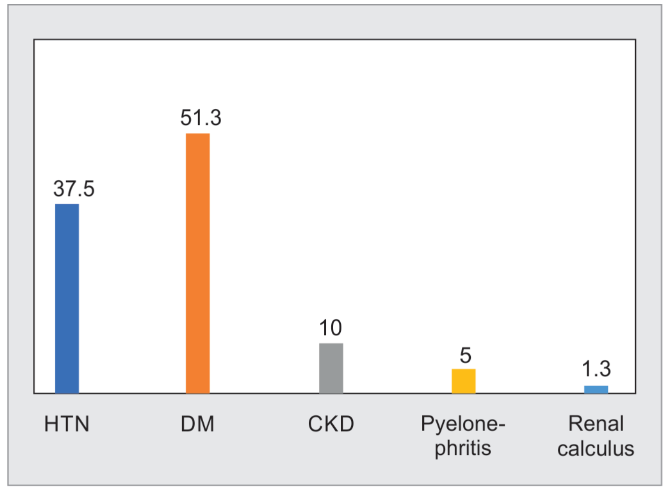

Fig. 3: Risk factors associated with CAUTI

Table 1: Socioeconomic characteristics and risk factors associated with CAUTI

Parameters and category	*Total patients*	*No. and percent of bacterial CAUTIs*	*OR (95% CI)*	*p-value*
Gender				
Male	53 (66.25)	37 (62.71)	1	1
Female	27 (33.75)	22 (37.28)	0.52 (0.168–1.636)	0.459
Age category				
21–30	7 (8.75)	6 (85.71)	1	0.472
31–40	5 (6.25)	5 (100)	0	0.182
41–50	4 (5)	2 (50)	0.1667 (0.0136–2.10)	0.28
51–60	14 (17.5)	12 (85.71)	1 (0.072–13.84)	0.39
> 60	50 (62.5)	34 (68)	0.3542 (0.046–2.72)	0.355
Reason for catheterization				
Urine incontinence	20 (25)	15 (75)	1	0.899
Pre/postoperative drainage	30 (37.5)	22 (73.33)	0.92 (0.42–2.01)	0.959
Urine measure	12 (15)	8 (66.66)	0.67 (0.25–1.78)	0.577
Urine retention	18 (22.5)	14 (77.77)	1.17 (0.55–2.49)	0.698
Place of catheter insertion				
Operation room	15 (18.75)	10 (66.66)	1	0.534
Emergency ward	20 (25)	15 (75)	1.5 (0.39–5.80)	0.898
Surgical ward	30 (37.5)	24 (80)	2 (0.71–5.63)	0.436
Medical ward	15 (18.75)	10 (66.66)	1 (0.32–3.09)	0.534
Duration of catheterization				
Short duration (<7 days)	37 (46.25)	24 (64.86)	1	0.154
Long duration (>7 days)	43 (53.75)	35 (81.39)	0.422 (0.152–1.171)	0.043
Risk factors				
Hypertension	30 (37.5)	18 (60)	1	1
Diabetes mellitus	41 (51.3)	32 (78)	2.37 (1.08–5.16)	0.0075
Chronic kidney disease	8 (10)	6 (75)	2 (0.78–5.10)	0.243
Pyelonephritis	4 (5)	2 (50)	0.67 (0.15–3.10)	0.611
Renal calculi	1 (1.3)	1 (100)	0	0.491

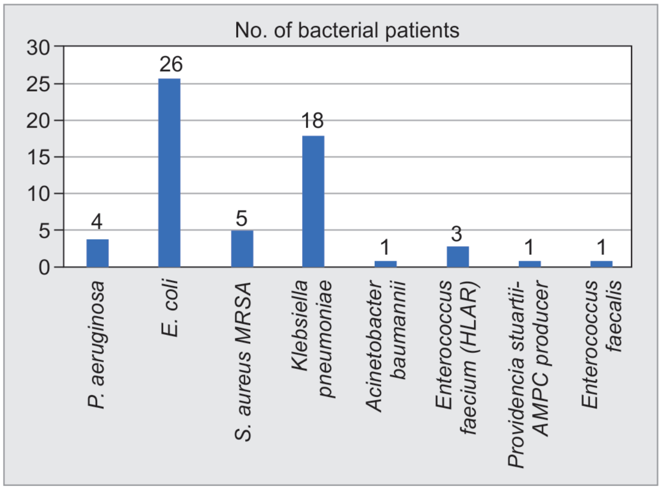

Fig. 4: Bacterial isolates among CAUTIs

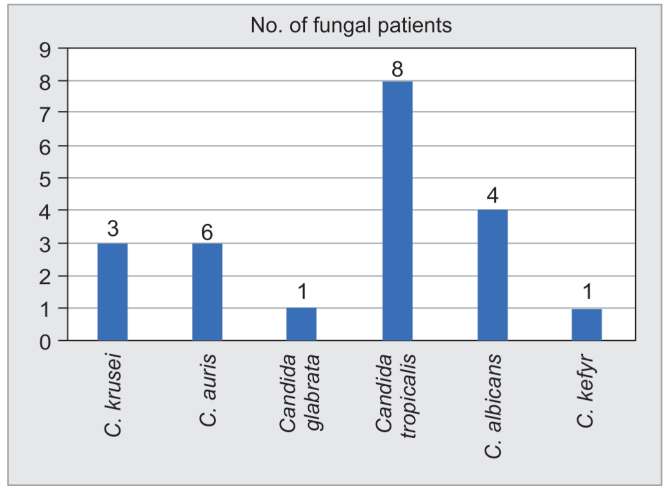

Fig. 5: Fungal isolates among CAUTIs

Table 2: Bacterial Isolates among CAUTI patients

Bacterial organisms	*No. of patients*	*Before catheterization*	*After catheterization*
P. aeruginosa	4	0	4
E. coli	26	5	21
S. aureus MRSA	5	1	4
K. pneumoniae	18	6	12
Acinetobacter baumannii	1	0	1
Enterococcus faecium (HLAR)	3	0	3
Providencia stuartii - AMPC producer	1	0	1
Enterococcus faecalis	1	0	1

The *p*-value for the above data is approximately 0.03

Table 3: Fungal isolates among CAUTI patients

Fungal organisms	*No. of patients*	*Before catheterization*	*After catheterization*
C. krusei	3	0	3
C. auris	6	2	4
C. glabrata	1	0	1
C. tropicalis	8	1	7
C. albicans	4	0	4
C. kefyr	1	0	1

The *p*-value for the above data is approximately 0.01

for 14 (34.14%). Of the bacterial isolates, nine out of 59 (15.25%) were gram-positive cocci and 50 out of 59 (84.74%) were gram-negative bacilli (Table 2). Out of 80 patients, 23 fungal isolates were found (28.75%) (Fig. 5). The two most often isolated organisms among the 23 isolates were *Candida tropicalis* 8/23 (34.78%) and *C. auris* 6/23 (26%) (Table 3).

Antibiotic Susceptibility Profiles of Bacterial Organisms

The patterns of antibiotic susceptibility in the organisms that cause CAUTIs were examined for different drug categories (Table 4). Resistance among urinary isolates was 94% for cefoperazone-sulbactam, 90% for ampicillin, 80% for cefepime, 86.44% for amoxicillin-clavulanic acid, 84% for aztreonam, 64.40% for cefuroxime, 64% for piperacillin-tazobactam, ceftriaxone, and ceftazidime, 62.71% for cefotaxime, and 61.01 for trimethoprim-sulfamethoxazole regardless of the bacterial species. Nitrofurantoin was highly effective against both gram-positive and gram-negative organisms, with a sensitivity of 54.23% (32/59), followed by gentamicin and ciprofloxacin, each with a sensitivity of 38.98% (23/59) and 44.04% (26/59), respectively. Resistance to the fluoroquinolone class varied from 54% (32/59) for levofloxacin to 64% (33/59) for ciprofloxacin. About 46% of bacterial isolates were found to be intermediate to colistin (Table 5).

Multidrug Resistance (MDR) Organisms of CAUTIs

Multidrug resistance was detected in 37 (88.1%) of the 82 isolates. All *Klebsiella* species exhibited MDR, with *E. coli* 16/17 (94.1%) coming in second.

Discussion

In our study, the incidence rate of CAUTI was found to be 77.12%, and the overall prevalence of symptomatic CAUTIs was 16.9%, which is comparable to rates in Sudan (16.37%), China (15.8%), and Uganda (15.3%).[6] This prevalence was greater than that of Italy (6.2%), USA (1.41%), and Australia (0.9%), but lower than that of studies conducted in Nigeria (60.9%) and India (42.9%).[7] Differences in research design, catheter care, infection control programs, and patient gender can all contribute to variations in prevalence.

CAUTIs were more than five times more common in diabetic individuals, which is consistent with research from Egypt, India, and Korea, possibly due to weakened host defenses related to hyperglycemia.[8] Insertion location also matters; compared with operating rooms, surgical ward catheterization patients had a 3.6 times higher risk of developing CAUTIs, likely due to improper techniques or poor hygiene.[9]

Escherichia coli plays an important role as it possesses pili capable of binding to the urinary epithelium and preventing their elimination by urine flow. The most common UTI isolates were *E. coli* (40.47%) and *Klebsiella* spp. (21.43%), consistent with findings in Northern India in ICU at a tertiary care hospital.[10] However,

Table 4: Drug susceptibility report for gram-negative bacteria

		Total (N = 50)	*E. coli (n = 26)*	*Klebsiella spp. (n = 18)*	*P. aeruginosa (n = 4)*	*Acinetobacter baumannii (n = 1)*	*Providencia stuartii (n = 1)*
Antimicrobial agents	*DSP*	*No. (%)*	*No. (%)*	*No. (%)*	*No. (%)*	*No. (%)*	*No. (%)*
Ampicillin	S	5 (10)	1 (3.84)	4 (22.22)	0 (0)	0 (0)	0 (0)
	R	45 (90)	25 (96.15)	14 (77.77)	4 (100)	1 (100)	1 (100)
Amoxicillin-clavulanic acid	S	5 (10)	2 (7.69)	3 (16.66)	0 (0)	0 (0)	0 (0)
	R	45 (90)	24 (92.30)	15 (83.33)	4 (100)	1 (100)	1 (100)
Piperacillin-tazobactam	S	18 (36)	10 (38.46)	5 (27.77)	2 (50)	0 (0)	1 (100)
	R	32 (64)	16 (61.53)	13 (72.22)	2 (50)	1 (100)	0 (0)
Amikacin	S	23 (46)	17 (65.38)	5 (27.77)	0 (0)	0 (0)	1 (100)
	R	27 (54)	9 (34.61)	13 (72.22)	4 (100)	1 (100)	0 (0)
Tobramycin	S	25 (50)	16 (61.53)	8 (44.44)	0 (0)	0 (0)	1 (100)
	R	25 (50)	10 (38.46)	10 (55.55)	4 (100)	1 (100)	0 (0)
Gentamicin	S	21 (42)	15 (57.69)	5 (27.77)	0 (0)	0 (0)	1 (100)
	R	29 (58)	11 (42.30)	13 (72.22)	4 (100)	1 (100)	0 (0)
Ciprofloxacin	S	23 (46)	17 (65.38)	4 (22.22)	0 (0)	1 (100)	1 (100)
	R	27 (54)	9 (34.61)	14 (77.77)	4 (100)	0 (0)	0 (0)
Levofloxacin	S	18 (36)	12 (46.15)	5 (27.77)	0 (0)	0 (0)	1 (100)
	R	32 (64)	14 (53.84)	13 (72.22)	4 (100)	1 (100)	0 (0)
Trimethoprim-sulfamethoxazole	S	19 (38)	14 (53.84)	5 (27.77)	0 (0)	0 (0)	0 (0)
	R	31 (62)	12 (46.15)	13 (72.22)	4 (100)	1 (100)	1 (100)
Cefuroxime	S	18 (36)	15 (57.69)	3 (16.66)	0 (0)	0 (0)	0 (0)
	R	32 (64)	11 (42.30)	15 (83.33)	4 (100)	1 (100)	1 (100)
Cefotaxime	S	18 (36)	14 (53.84)	3 (16.66)	0 (0)	0 (0)	1 (100)
	R	32 (64)	12 (46.15)	15 (83.33)	4 (100)	1 (100)	0 (0)
Ceftazidime	S	18 (36)	15 (57.69)	2 (11.11)	0 (0)	0 (0)	1 (100)
	R	32 (64)	11 (42.30)	16 (88.88)	4 (100)	1 (100)	0 (0)
Ceftriaxone	S	17 (34)	14 (53.84)	2 (11.11)	0 (0)	0 (0)	1 (100)
	R	33 (66)	12 (46.15)	16 (88.88)	4 (100)	1 (100)	0 (0)
Cefixime	S	11 (22)	6 (23.07)	4 (22.22)	0 (0)	0 (0)	1 (100)
	R	39 (78)	20 (76.92)	14 (77.77)	4 (100)	1 (100)	0 (0)
Cefepime	S	10 (20)	5 (19.23)	2 (11.11)	2 (50)	0 (0)	1 (100)
	R	40 (80)	21 (80.76)	16 (88.88)	2 (50)	1 (100)	0 (0)
Cefoperazone-sulbactam	S	3 (6)	1 (3.84)	1 (5.55)	0 (0)	0 (0)	1 (100)
	R	47 (94)	25 (96.15)	17 (94.44)	4 (100)	1 (100)	0 (0)
Aztreonam	S	8 (16)	6 (23.07)	1 (5.55)	0 (0)	0 (0)	1 (100)
	R	42 (84)	20 (76.92)	17 (94.44)	4 (100)	1 (100)	0 (0)
Meropenem	S	24 (48)	17 (65.38)	4 (22.22)	2 (50)	0 (0)	1 (100)
	R	26 (52)	9 (34.61)	14 (77.77)	2 (50)	1 (100)	0 (0)
Imipenem	S	24 (48)	15 (57.69)	8 (44.44)	0 (0)	0 (0)	1 (100)
	R	26 (52)	11 (42.30)	10 (55.55)	4 (100)	1 (100)	0 (0)
Ertapenem	S	16 (32)	9 (34.61)	6 (33.33)	0 (0)	0 (0)	1 (100)
	R	34 (68)	17 (65.38)	12 (66.66)	4 (100)	1 (100)	0 (0)
Nitrofurantoin	S	27 (54)	18 (69.23)	8 (44.44)	0 (0)	0 (0)	1 (100)
	R	23 (46)	8 (30.76)	10 (55.55)	4 (100)	1 (100)	0 (0)
Fosfomycin	S	23 (46)	17 (65.38)	6 (33.33)	0 (0)	0 (0)	0 (0)
	R	27 (54)	9 (34.61)	12 (66.66)	4 (100)	1 (100)	1 (100)
Colistin	S	2 (4)	0 (0)	2 (11.11)	0 (0)	0 (0)	0 (0)
	I	21 (42)	7 (26.92)	12 (66.66)	2 (50)	0 (0)	0 (0)
	R	27 (54)	19 (73.07)	4 (22.22)	2 (50)	1 (100)	1 (100)

DSP, drug susceptibility pattern; I, intermediate, R, resistant; S, sensitive

Table 5: Drug susceptibility report for gram-positive bacteria

Antimicrobial agents	*DSP*	*Total (N = 9)* *No. (%)*	*Staphylococcus aureus (n = 5)* *No. (%)*	*Enterococcus spp. (n = 4)* *No. (%)*
Amoxicillin-clavulanic acid	S	3 (33.33)	2 (40)	1 (25)
	R	6 (66.66)	3 (60)	3 (75)
Cloxacillin	S	3 (33.33)	3 (60)	0 (0)
	R	6 (66.66)	2 (40)	4 (100)
Gentamicin	S	2 (22.22)	2 (40)	0 (0)
	R	7 (77.77)	3 (60)	4 (100)
Ciprofloxacin	S	3 (33.33)	1 (20)	2 (50)
	R	6 (66.66)	4 (80)	2 (50)
Moxifloxacin	S	2 (22.22)	2 (40)	0 (0)
	R	7 (77.77)	3 (60)	4 (100)
Doxycycline	S	5 (55.55)	3 (60)	2 (50)
	R	4 (44.44)	2 (40)	2 (50)
Gatifloxacin	S	1 (11.11)	1 (20)	0 (0)
	R	8 (88.88)	4 (80)	4 (100)
Trimethoprim-sulfamethoxazole	S	4 (44.44)	4 (80)	0 (0)
	R	5 (55.55)	1 (20)	4 (100)
Cefazolin	S	3 (33.33)	3 (60)	0 (0)
	R	6 (66.66)	2 (40)	4 (100)
Cefuroxime	S	3 (33.33)	3 (60)	0 (0)
	R	6 (66.66)	2 (40)	4 (100)
Cefotaxime	S	4 (44.44)	4 (80)	0 (0)
	R	5 (55.55)	1 (20)	4 (100)
Ceftriaxone	S	4 (44.44)	4 (80)	0 (0)
	R	5 (55.55)	1 (20)	4 (100)
Cefaclor	S	3 (33.33)	3 (60)	0 (0)
	R	6 (66.66)	2 (40)	4 (100)
Nitrofurantoin	S	5 (55.55)	2 (40)	3 (75)
	R	4 (44.44)	3 (60)	1 (25)
Clindamycin	S	1 (11.11)	1 (20)	0 (0)
	R	8 (88.88)	4 (80)	4 (100)
Vancomycin	S	5 (55.55)	1 (20)	4 (100)
	R	4 (44.44)	4 (80)	0 (0)
Teicoplanin	S	5 (55.55)	1 (20)	4 (100)
	R	4 (44.44)	4 (80)	0 (0)
Linezolid	S	5 (55.55)	1 (20)	4 (100)
	R	4 (44.44)	4 (80)	0 (0)
Rifampicin	S	1 (11.11)	1 (20)	0 (0)
	R	8 (88.88)	4 (80)	4 (100)

DSP, drug susceptibility pattern; I, intermediate, R, resistant; S, sensitive

Pseudomonas aeruginosa and *Enterococcus* spp. dominated in studies from Italy, Thailand, and Sudan, likely due to environmental and procedural differences.[11] Gram-negative bacteria showed high resistance to commonly used drugs like ampicillin (100%) and tetracycline (86.6%), but remained susceptible to nitrofurantoin (96.7%) and meropenem (87.9%).[12]

Our study also highlighted that prolonged catheterization increased the risk of CAUTIs, with 93.33% of patients with catheters over 10 days developing infections.[13] Additionally, the use of fluoroquinolones like ciprofloxacin has become less effective, confirming rising drug resistance.[14]

Limited studies make it difficult to compare CAUTI rates and associated risk factors over time. However, the urine sample collection method in our study aligns with prior research and is more sensitive than alternative methods.[15] The main limitations of our study include its short duration (8 months), reliance on retroprospective data, and the limited number of hospitals involved. Further research is needed, using prospective designs and larger patient populations, to better understand CAUTI incidence and its impact on antibiotic resistance in ICUs.[16]

Conclusion

In summary, *K. pneumonia*e, *E. coli*, *C. tropicalis*, and *C. auris* were identified as the predominant microbes in CAUTI cases in the ICU. Gram-negative bacteria exhibited MDR and PDR. The CAUTI is a major issue that heightens nosocomial infections and antibiotic resistance. It is highly advised that further study be done on the bacteria causing MDR as well as CAUTI variables across several centers.

The current study indicates that MDR *E. coli*, *Klebsiella*, and *Enterococcus* spp. are leading pathogens in CAUTI patients. Fosfomycin shows potential for treating patients with drug-resistant uropathogens. Effective management of CAUTIs requires understanding bacterial etiology and local AMR prevalence. Large-scale studies for regular AMR surveillance among catheterized patients in hospitals are necessary. Creating local antibiograms can help physicians select suitable antibiotics for CAUTIs, reducing morbidity, and the financial burden on healthcare systems.

The prevalence of CAUTIs is 73.75%, with *E. coli* and *Klebsiella* spp. being the primary causative agents. Empirical therapy typically includes piperacillin-tazobactam, ceftazidime-avibactam, and meropenem due to their efficacy against CAUTI pathogens.

However, there is a concerning trend of increased AMR among bacterial isolates. Thus, treatment strategies must align with microbial etiology and resistance patterns, necessitating regular surveillance. CAUTIs pose significant risks to patients, exacerbating existing conditions and imposing financial burdens. Microbiological testing is crucial for identifying pathogens and selecting appropriate antibiotics. Minimizing catheterization duration is key to reducing CAUTI incidence, alongside implementing evidence-based catheter care protocols through hospital-wide surveillance programs.

Clinical Significance

The findings highlight the urgent need for continuous AMR surveillance and the development of targeted infection control strategies. This research is crucial in guiding clinical practices to improve patient outcomes and combat the growing threat of AMR.

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