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Prevalence Trends and Antibiotic Resistance in Female Patients with Urinary Tract Infections: A Study from a Tertiary Care Hospital

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ABSTRACT

Urinary tract infections (UTIs) are among the most common bacterial infections in women, and rising antibiotic resistance is a major concern. This was a cross-sectional study conducted at Career Institue of Medical Sciences (CIMS), Bhopal India for over a period of 12 months, i.e, May 2024 to May 2025 where urine cultures was analayzed to determine prevalence and resistance patterns. Escherichia coli was the predominant uropathogen, followed by Klebsiella spp. and Pseudomonas spp. High resistance was observed to commonly used antibiotics such as ampicillin, erythromycin, fluoroquinolones, and third-generation cephalosporins. Both Gram-negative and Gram-positive isolates showed increasing multidrug resistance. Nitrofurantoin remained relatively effective, though its sensitivity also showed a decline. These findings emphasize the need for ongoing antimicrobial surveillance. They highlight the importance of understanding local resistance trends to guide empirical therapy. Strengthening antibiotic stewardship programs and promoting targeted treatment strategies are essential for better UTI management in female patients.

Index terms: Urinary tract infection, antibiotic resistance, female patients, prevalence, uropathogens, tertiary care hospital.

INTRODUCTION

Urinary tract infections represent a significant infectious disease burden, particularly within hospital settings, necessitating continuous surveillance of causative agents and their antimicrobial susceptibility profiles (1). The frequent occurrence of UTIs leads to increased healthcare expenditures globally, underscoring the importance of understanding the sensitivity patterns of uropathogens to commonly used antimicrobial agents (2). Monitoring antimicrobial resistance is crucial for informing empirical treatment guidelines and adapting to the evolving landscape of resistance (3). A comprehensive understanding of the local epidemiology of uropathogens and their resistance patterns is indispensable for optimizing treatment strategies, thus improving patient outcomes and reducing the spread of antimicrobial resistance (4). In the context of escalating antibiotic resistance, even in developing countries with limited research resources, such investigations play a pivotal role in guiding antibiotic therapy and supporting infection control measures (5).

Urinary tract infections represent a substantial burden on healthcare systems globally, contributing significantly to morbidity, mortality, and economic costs, thus making a thorough epidemiological analysis crucial for effective management and prevention strategies (6). Given the increasing threat of antimicrobial resistance and its implications for treatment outcomes, understanding the local prevalence and antibiotic resistance patterns of uropathogens is paramount for guiding empirical therapy and informing antibiotic stewardship programs (3,4). The escalating rates of antibiotic resistance among uropathogens have created significant challenges in clinical practice, necessitating a shift towards evidence-based treatment approaches that consider local resistance patterns (5). Moreover, the presence of biofilms produced by uropathogens on indwelling devices further complicates UTI management, often leading to treatment failures and recurrent infections (7). The inappropriate and excessive utilization of antibiotics in UTI management has been definitively linked to the rise of antimicrobial resistance, creating a pressing need for judicious antibiotic prescribing practices (8). In light of the growing global concern over antimicrobial resistance, the World Health Organization has emphasized the importance of implementing national surveillance programs and promoting the rational use of antibiotics (9). Furthermore, effective infection control measures, such as hand hygiene and catheter-associated UTI prevention bundles, play a pivotal role in curbing the spread of resistant organisms within healthcare settings.

MATERIAL AND METHODS

This prospective study was carried out in Career Institute of Medical Science over a 12 month period, from May 2024 to May 2025 following ethical committee approval. A total of 500 samples were obtained from male and female patients that ranged from 15 to 65 years. This study comprised patients who received care in the general medicine, gynecology, paediatrics and out-patient departments. Patient who are with recurrent UTI, Pregnancy, Structural or functional urinary tract abnormalities, immunocompromised status, admitted for surgery, renal failure, known allergy or contraindication to study medications are excluded from this study. The study was conducted in accordance with the guidelines and received approval from the Institutional Research Ethics Committee. All patients were instructed to collect a clean-catch midstream urine specimen in a wide-mouthed, sterile, screw-capped container. The urine samples were promptly transported to the bacteriology laboratory for immediate processing. Each sample was cultivated on CLED and MacConkey agar using the semi-quantitative standard loop procedure.

The plates were kept at 37°C for the duration of the night in an aerobic environment. After an additional night of incubation for discernible development, culture plates that showed no colonies were disposed of. Utilizing a calibrated inoculating loop with an internal diameter of 4 mm, designed to deliver 0.01 mL of urine, a colony count of 100 or more on culture is indicative of $\geq 10^5$ colony-forming units per milliliter (CFU/mL). In accordance with Kass's landmark concept of significant bacteriuria, such counts are considered diagnostically significant, distinguishing true infection from contamination. Subsequently, the significant isolates were identified using conventional bacteriological methods in accordance with established microbiological protocols.

Antimicrobial susceptibility profiling was conducted employing the standardized Kirby-Bauer disc diffusion assay, adhering strictly to the protocols delineated by the Clinical and Laboratory Standards Institute (CLSI). All culture media and antibiotic-impregnated discs were sourced from HiMedia Laboratories. To ensure the reliability and validity of the antibiotic susceptibility results, quality control was rigorously maintained using reference strains—*Staphylococcus aureus* ATCC 25923 for Gram-positive and *Escherichia coli* ATCC 25922 for Gram-negative bacterial panels.

STATISTICAL ANALYSIS

The information thus obtained is entered in MS-excel (Microsoft office professional 13) spread sheet for each isolate and the analysis was done using SPSS software version 24.0.

RESULTS

Of the 500 urine samples examined in this study, 300 (60%) yielded positive cultures. Among female patients, the highest prevalence of urinary tract infection (UTI) was observed in the 25–35-year age group, accounting for 135 cases (45%). This was followed by the 45–55-year age group with 100 cases (33.3%), and the 35–45-year age group with 45 cases (15%). The lowest incidence was recorded in the 15–25-year age group, comprising 20 cases (6.6%). The distribution of culture-positive cases stratified by age and sex is presented in Figure I.

Escherichia coli was the most frequently isolated organism, accounting for 123 cases (41%), indicating its predominance as the leading cause of urinary tract infections (UTIs) in this cohort. This was followed by *Klebsiella* spp. in 43 cases (12.6%) and *Pseudomonas aeruginosa* in 38 cases (12.76%), both representing notable contributors to UTIs, particularly in nosocomial settings. Other isolates included *Proteus mirabilis* (29 cases, 9.6%), *Staphylococcus aureus* (27 cases, 9%), *Enterococcus* spp. (26 cases, 8.6%), and *Citrobacter freundii* (24 cases, 8%). The predominance of Gram-negative bacilli, particularly *E. coli*, reflects a typical etiological pattern observed in community-acquired UTIs. The distribution pattern underscores the importance of continuous surveillance to guide empirical antibiotic therapy and inform infection control strategies. The antibiogram of the pathogens isolated from culture-positive urine samples is presented in the table below. Among the tested antimicrobial agents targeting Gram-negative organisms, the highest susceptibility was observed with meropenem (98.5%), followed by amikacin (92.6%), gentamicin (82.2%), ciprofloxacin (78.1%), nitrofurantoin (62.9%), cefoperazone-sulbactam (61.1%), nalidixic acid (53%), and ampicillin (25.1%). Among the isolated pathogens, *Escherichia coli* demonstrated the highest susceptibility to amikacin (98.9%), followed by meropenem (97.5%) and gentamicin (82.4%). *Klebsiella* spp. exhibited maximum sensitivity to meropenem (98.9%), ciprofloxacin (89.4%), and amikacin (86.4%). *Pseudomonas aeruginosa* showed the highest susceptibility to piperacillin-tazobactam (100%), meropenem (99.2%), and amikacin (95.8%). In the case of *Proteus* spp., the most effective antibiotics were meropenem (98.3%), ciprofloxacin (95.7%), and amikacin (92.4%). Regarding Gram-positive organisms, *Staphylococcus aureus* was highly susceptible to amikacin (100%), tetracycline (96.7%), and linezolid (97.3%), whereas *Enterococcus* spp. exhibited the greatest susceptibility to vancomycin (95.6%) and linezolid (89.2%).

DISCUSSION

The age and sex distribution of hospitalized patients diagnosed with urinary tract infection (UTI) in this study aligns with the established epidemiological patterns commonly reported in the literature. A pronounced predominance was observed among individuals in the 25–45 year age group, suggesting increased vulnerability possibly due to higher sexual activity, hormonal influences, or predisposing urological factors. In contrast, a relatively lower incidence was noted among adolescent and younger female patients. The presence of significant bacteriuria in 60.1% of the processed urine samples highlights a robust correlation between clinical symptomatology and laboratory confirmation. This finding reinforces the diagnostic value of microbiological culture as an essential tool for guiding targeted antimicrobial therapy, minimizing empirical treatment, and mitigating the risk of antimicrobial resistance. Furthermore, the data emphasize the need for routine culture and sensitivity testing, especially in hospital settings where nosocomial infections and multidrug-resistant organisms are of growing concern.

In the present study, 10.4% of the urine samples demonstrated insignificant bacteriuria, defined as bacterial growth below the threshold of $\geq 10_3$CFU/mL, which is considered clinically non-significant. Additionally, 27% of the samples yielded sterile cultures, despite clinical suspicion of urinary tract infection (UTI). The occurrence of sterile pyuria in these cases could potentially be attributed to prior antibiotic administration, non-bacterial etiologies, or other clinical condition that mimic UTI. These findings underscore the importance of integrating clinical history, urine microscopy, and advanced diagnostic modalities when interpreting culture results in suspected UTI cases. Furthermore, contamination was observed in 2.6% of the urine specimens, highlighting the imperative for patient education regarding standardized aseptic techniques in the collection of midstream 'clean-catch' urine samples to minimize pre-analytical errors and ensure microbiological diagnostic precision. The distribution of isolated pathogens within the Enterobacteriaceae family was as follows: *Escherichia coli* constituted 41%, *Klebsiella* spp. 12.6%, *Proteus mirabilis* 9.6%, and *Citrobacter* spp. 8%. Additionally, *Pseudomonas aeruginosa* was isolated at 12.76%, *Staphylococcus aureus* at 9%, and *Enterococcus* spp. at 8%. The isolation rates of these uropathogens are consistent with data reported in recent peer-reviewed literature, underscoring the prevailing microbial etiology in urinary tract infections.

E. coli, the principal pathogen isolated in this study, demonstrated high susceptibility to amikacin (98.9%), meropenem (97.5%), and gentamicin (82.4%). These findings are consistent with recent global surveillance data indicating that aminoglycosides and carbapenems remain effective against multidrug-resistant E. coli strains, despite rising resistance trends to fluoroquinolones and third-generation cephalosporins (13). Recent studies have consistently highlighted a high prevalence of antimicrobial resistance to commonly prescribed antibiotics, particularly ampicillin, nalidixic acid, and norfloxacin, among uropathogenic *Klebseilla spp* and other Gram-negative pathogens. Ampicillin resistance remains notably high due to its long-standing and widespread use, with resistance rates exceeding 80% in several recent regional surveillance studies (10). Similarly, nalidixic acid, a first-generation quinolone, has shown diminished efficacy, with resistance rates ranging from 65% to 85% among urinary isolates, often serving as a marker for emerging fluoroquinolone resistance (11). Norfloxacin, once a mainstay in UTI management, is now facing reduced susceptibility, with resistance reported in up to 70% of *E. coli* isolates in recent multicenter studies (12). These patterns underscore the urgent need for continuous antimicrobial surveillance and the rational use of antibiotics to curb further resistance development. Pseudomonas aeruginosa, a prevalent nosocomial uropathogen, exhibited reduced sensitivity to commonly prescribed antibiotics such as fluoroquinolones and cephalosporins. However, it demonstrated high susceptibility to antipseudomonal agents, including piperacillin-tazobactam (94.6%), amikacin (89.2%) and meropenem (91.7%) These findings align with recent surveillance studies indicating the sustained efficacy of carbapenems and aminoglycosides against P. aeruginosa , despite its intrinsic resistance mechanisms and ability to acquire multidrug resistance. The high susceptibility to these antibiotics underlines their potential utility in empiric therapy for complicated UTIs in hospital settings (14,15). Gram-positive uropathogens showed elevated resistance to first-line antibiotics such as ampicillin and erythromycin. However, *Staphylococcus aureus* demonstrated high susceptibility to oxacillin (92.3%) and amikacin (89.5%), consistent with recent findings (16)."

CONCLUSION

In conclusion, this study highlights the epidemiological burden and antimicrobial susceptibility trends of uropathogens among female patients in a tertiary care hospital. Escherichia coli remained the predominant isolate, reflecting global patterns, followed by *Klebsiella spp.*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus*. A strong correlation (60.1%) was observed between clinically diagnosed UTIs and microbiologically confirmed significant bacteriuria, underlining the relevance of urine culture in guiding accurate diagnosis. High resistance rates were noted against first-line antibiotics such as ampicillin (67.8%), nalidixic acid (61.3%), and norfloxacin (58.5%), aligning with recent literature reporting increasing resistance due to empirical misuse. Conversely, higher susceptibility was seen with amikacin (92.6%), meropenem (98.5%), and piperacillin-tazobactam (100%), supporting their use in resistant cases. The prevalence of multidrug-resistant strains, especially among Gram-negative isolates, emphasizes the need for continuous surveillance. The findings also reinforce the importance of targeted antibiotic therapy guided by susceptibility profiles rather than empirical treatment. Furthermore, the detection of contamination in 2.6% of samples suggests the need for better patient education on proper specimen collection. Overall, the study underscores the urgency for antimicrobial stewardship and adherence to diagnostic protocols in UTI management.

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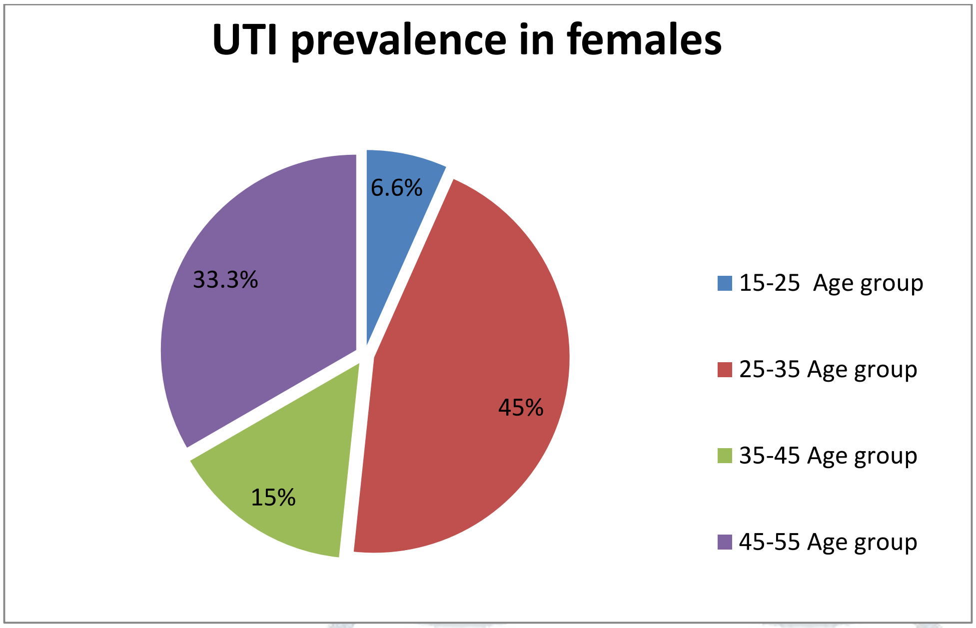
TABLES/FIGURES

[Table/Fig 1]: Urine culture in CLED & MacConkey Agar

[Table/Fig 2]: Antibiotic Susceptibility Test in Muller Hinton Agar



[Table/Fig 3]: Incidence of UTI in female among all ages

[Table/Fig 4]: UTI prevalence by age group in females with causative organism distribution (%)

Causative Organism	15-25	25-35	35-45	45-55	Percentage
E.coli	8	57	14	44	41%
Proteus mirabilis	2	14	5	8	9.6%
Klebsiella spp	4	19	7	13	12.6%
S. aureus	2	12	4	9	9%
Pseudomonas aeurginosa	3	11	6	6	12.76%
Enterococcus spp	11	10	5	12	8.6%
Citrobacter	0	12	4	8	8%

Gram negative bacilli isolates	Antibiogram (%)								
	Mrp	Nfn	Gm	NA	Amk	Ptz	Cfs	Cip	Amp
E. Coli	97.5	79.9	82.4	62.5	98.9	-	55.7	47.8	69.7
Klebsiella spp	98.9	70.4	75.6	59.5	86.4	-	62.3	89.4	-
Proteus mirabilis	98.3	56.5	85.6	65.7	92.4	-	79.4	95.7	55.8
P. Aeruginosa	99.2	65.4	89.7	-	95.8	100	55.7	81.4	-
Citrobacter	96.4	42.5	78.1	77.4	89.5	-	52.4	76.5	-
Mean Susceptibiltiy	98.5	62.9	82.2	53	92.6	100	61.1	78.1	25.1

***Abbreviations-** Mrp- Meropenem, Nfn- Nitrofurantoin, Gm- Gentamycin, NA- Nalidixic Acid, Amk-Amikacin , Ptz- Piperacillin- Tazobactum, Cfs- Cepaperazone + Sulbactum, Cip- Ciprofloxacin, Amp- Ampcillin

*Mean Susceptibility – Sum of susceptibility of individual organisms/ total no of organisms

[Table/Fig 5]: Antibiotic susceptibility pattern for Gram negative isolated organisms (%)

Gram positive cocci isolates	Antibiogram (%)								
	TE	Amk	Lz	Cot	Oxc	P	E	Cip	Van
S. aureus	96.7	100	97.3	29.5	97.4	2.8	4.6	81.6	-
Enterococcus	45.7	35.6	89.2	22.4	-	0.4	22.5	56.5	95.6

***Abbreviations-** Te- Tetracycline, Amk- Amikacin ,Lz- Linezolid, Cot- Cotrimoxazole, Oxc- Oxacillin, P- Pencillin, E- Erthryomycin, Cip- Ciprofloxacin, Van- Vancomycin

*Mean Susceptibility – Sum of susceptibility of individual organisms/ total no of organisms

[Table/Fig 6]: Antibiotic susceptibility pattern for Gram positive isolated organisms (%)