Original Article

Urinary Pathogens and Their Antibiotic Resistance Pattern Among Patients in A Tertiary Care Hospital

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Abstract

Background: Urinary Tract Infections (UTIs) are among the most prevalent infections worldwide, affecting [1] [2]. Various factors increase the risk for UTIs, including sexual activity, vaginal infections, diabetes, hygiene practices, obesity, and genetic predisposition [3]. UTIs are mainly caused by Gram-negative organisms like Escherichia coli, Klebsiella species, Proteus species, and Pseudomonas species, and Gram-positive bacteria like Enterococcus species, Staphylococcus aureus, and CONS (Staphylococcus saprophyticus). Among these organisms, E. coli is the most common causative organism for community-acquired and hospital-acquired UTIs [5]. **Material and Methods:** The study was conducted in the department of microbiology of Teerthanker Mahaveer Medical College and Research Centre from January 2025 to June 2025 after approval (IRB/134/2025 dated 16 June 2025). A total of 3031 samples were processed. Mid-stream clean catch samples or from the catheter port were collected for culture and antibiotic sensitivity testing. Samples were processed using a calibrated loop and inoculated semi quantitatively on a CLED agar plate as per Kass's recommendations [10]. The identification of bacterial isolates and the antibiotic susceptibility test (AST) were performed manually and using an automated method (VITEK 2). HiCrome agar by HiMedia was used to identify *Candida* isolates. **Results:** In our study, 89 OPD and 308 IPD samples were culture-positive. Females were more frequently affected than males. The most common organisms isolated in OPD and IPD samples were *E. coli* (53.9% and 42.2%, respectively), *Klebsiella pneumonia* (12.4%), and *Enterococcus spp*. (12.4%), and *Candida parasilopsis* (11%). Antibiotics that were more sensitive among Gram-negative organisms were Nitrofurantoin, Aminoglycoside, Carbapenems, and Fosfomycin, whereas among Gram-positive organisms, Nitrofurantoin, Linezolid, Teicoplanin, and Vancomycin were more sensitive. There was a significant association between age and E. coli isolation (χ^2=18.34, df=3, p=0.001), and gender-wise, E. coli was found more in females (29.7%) than in males (15.1%), with statistical significance (χ^2=16.27, df=1, p=0.001). **Conclusion:** The current study aims to detect and determine the hospital-based prevalence of UTI, its causative agents, and their antimicrobial susceptibility patterns. This study will also help to create recommendations for determining effective empirical therapy/ antibiotic policy for UTIs while waiting for culture sensitivity results.

Keywords: UTI, AST, Antimicrobial resistance.

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Introduction

Urinary Tract Infections (UTIs) are among the most prevalent infections worldwide. They affect the lower urinary tract (bladder and urethra) and the upper urinary tract (kidney and ureter). [1,2] Although UTIs can affect any age group, including men and women, clinical studies suggest that the overall prevalence of UTIs is significantly higher in women.

The various factors that increase the risk for UTIs include sexual activity, vaginal infections, diabetes, hygiene practices, obesity, and genetic predisposition.[3]

Bacteria first colonize and then infect the urinary tract, resulting in symptoms such as dysuria, urinary incontinence, and hematuria.[4]

The clinical presentation may range from an asymptomatic urinary tract infection to a life-threatening illness like sepsis. UTI infections are mainly caused by Gram-negative organisms like *Escherichia coli*, *Klebsiella* species, *Proteus* species, and *Pseudomonas* species, and Gram-positive bacteria like *Enterococcus* species, *Staphylococcus aureus*, and CONS (*Staphylococcus saprophyticus*). Among these organisms, *E. coli* is the most common causative organism for community-acquired and hospital-acquired UTIs. [5]

Empirical treatment of UTIs is common in rural areas due to the restricted availability of urine culture testing. This inadequate diagnosis often leads to the misuse of antibiotics. Knowing the area's antibiotic susceptibility pattern is crucial for deciding the empirical selection of antibiotics. [6,7]

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Developing nations like India are more vulnerable to the emergence of antimicrobial resistance (AMR) due to poor hygiene, inadequate infection control practices, and a lack of surveillance and implementation of antimicrobial stewardship programs. Self-medication and non-adherence to the prescribed antibiotic regimen also contribute to the emergence of AMR.[8]

The antibiotic susceptibility pattern for uropathogens varies spatially and temporally in different regions. Thus, antimicrobial susceptibility data are pivotal in generating contemporary and wide-ranging epidemiological data.[9]

Our study aims to identify the spectrum of uropathogens prevalent in our region and their antimicrobial susceptibility patterns. This study will help shape and reform our institute's antibiotic policy for better patient outcomes and facilitate a way forward in introducing and implementing antimicrobial stewardship.

Materials and Methods

The study was conducted in the department of microbiology of Teerthanker Mahaveer Medical College and Research Centre from January 2025 to June 2025 after approval (IRB/134/2025 dated 16 June 2025). A total of 3031 samples were processed, including those from inpatient (IPD) and outpatient departments (OPD).

Midstream clean catch samples or from the catheter port in case of cauterized patients were collected in a wide-mouth sterile container for culture and antibiotic sensitivity testing.

Samples were processed using a calibrated loop and inoculated semi quantitatively on a CLED agar plate as per Kass's recommendations.[10] The plates were then incubated at 37ºC aerobically for 24 hrs. Culture plates were then examined for bacterial growth. A 10^5CFU/ml bacterial count was taken as a significant count.[11]

The identification and antibiotic susceptibility test (AST) for the bacterial isolates was done manually and by VITEK 2, an automated system by bioMérieux. HiCrome agar by HiMedia was used to identify Candida isolates.

Antimicrobial agents were tested against the bacterial isolates, and the results were interpreted according to Clinical and Laboratory Standards Institute (CLSI) guidelines 2025.

Data was analyzed using SPSS version 25.0. Categorical variables were expressed as frequency and percentage. Associations between organisms and age groups (df=3) or gender (df=1) were assessed using the Chi-square test; Fisher's exact test was applied when expected counts were <5. A P value of <0.05 was considered statistically significant.

Results

In our study, 89 OPD and 308 IPD samples were culture positive. Age group-wise, the 20-30 years range shows the maximum infectivity, with 21.3% and 19.2 %, respectively, in OPD and IPD patients. The positivity rate was found to be lowest below 10 years of age and highest above 90 years of age.

Table 1: Distribution of study participants as per age groups

Age Group (Years)	OPD		IPD	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
0–9	4	4.5	10	3.2
10–19	4	4.5	16	5.2
20–29	19	21.3	59	19.2
30–39	8	9.0	41	13.3
40–49	13	14.6	48	15.6
50–59	16	18.0	47	15.3
60–69	14	15.7	47	15.3
70–79	7	7.9	30	9.7
80–89	3	3.4	10	3.2
90–99	1	1.1	0	0.0
Total	89	100.0	308	100.0
Mean ±SD	46.42		20.97	

Table 2: Distribution of study participants as per Gender

Gender	OPD		IPD	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Male	36	40.4	109	35.4
Female	53	59.6	199	64.6
Total	89	100.0	308	100.0

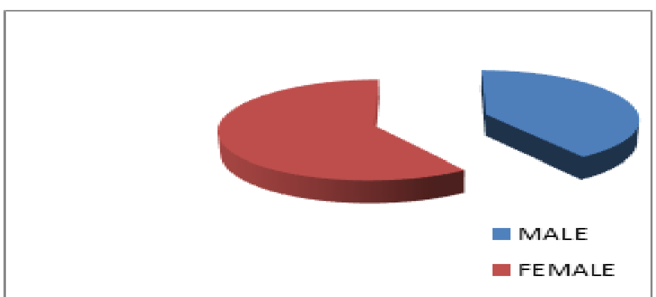

Figure 1: OPD samples

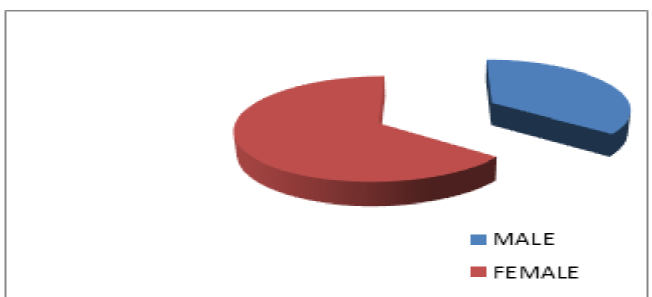

Figure 2: IPD samples

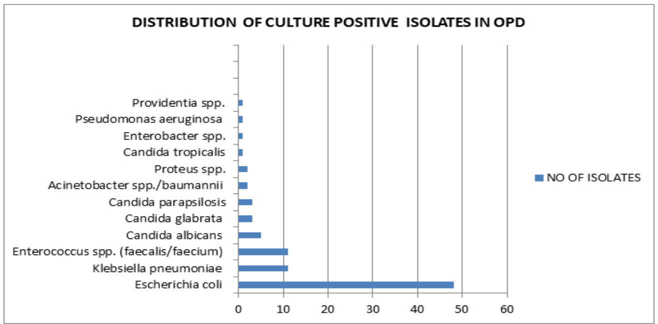

Figure 3: Distribution of Isolated Organisms in OPD

In our study, females were more frequently affected than males. In OPD, 59.6% were females and 40% were males. Whereas in IPD patients, females were 64% positive and males were 35.4%.

In OPD samples, the most common organism isolated was *E.coli* (53.9%), *Klebsiella pneumoniae* (12.4%), and *Enterococcus spp*. (12.4%).

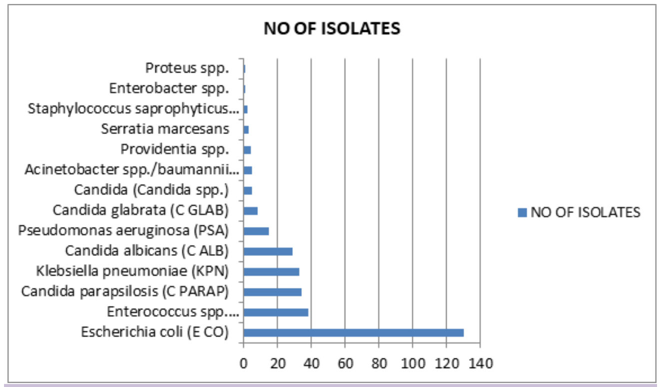

Figure 4: Distribution of Isolated Organisms in IPD

In IPD samples, again *E.coli* (42.2%) was the most predominant isolate followed by Enterococcus spp. (12.3%), *Candida parasilopsis* (11%) and *Klebsiella pneumonia* (10.7%).

Table 3: Antibiotic Susceptibility in OPD and IPD patients

Organism	Most Active (S ≥70%)	High Resistance (R ≥50%)
Escherichia coli	Nitrofurantoin, Fosfomycin, Amikacin, Chlormaphenicol	Ampicillin, Amoxicillin/Clavulanate, Fluoroquinolones
Klebsiella pneumoniae	Amikacin, Imipenem, Meropenem	Ampicillin, Amoxicillin/Clavulanate, Cephalosporins
Enterobacter spp.	Amikacin, Gentamicin	Amoxicillin/Clavulanate, Ampicillin/Sulbactum,, Cephalosporins
Proteus spp.	Amikacin, Gentamicin, Piperacillin/Tazobactum	Ampicillin, Amoxicillin/Clavulanate
Providentia spp.	Amikacin, Imipenem	Ampicillin, Amoxicillin/Clavulanate
Serratia marcescens	Amikacin, Gentamicin	Ampicillin, Amoxicillin/Clavulanate
Pseudomonas aeruginosa	Amikacin, Imipenem, Meropenem	Ciprofloxacin, Levofloxacin, Ticarcillin/Clavulanate
Acinetobacter spp.	Imipenem, Meropenem, Amikacin	Ciprofloxacin, Piperacillin/Tazobactum, Cephalosporins
Enterococcus spp.	Vancomycin, Linezolid, Teicoplanin	Ciprofloxacin, Levofloxacin, Erythromycin
Staphylococcus saprophyticus	Nitrofurantoin, Linezolid, Vancomycin, Teicoplanin	Ampicillin, Penicillin

In our study, the antibiotics that are >70 % sensitive among Gram-negative organisms were Nitrofurantoin, Aminoglycoside, Carbapenems, and Fosfomycin, whereas among Gram-positive organisms, Nitrofurantoin, Linezolid, Teicoplanin, and Vancomycin were the most sensitive antibiotics. Furthermore, the most resistant antibiotics were Penicillins, Cephalosporins, and Fluoroquinolones.

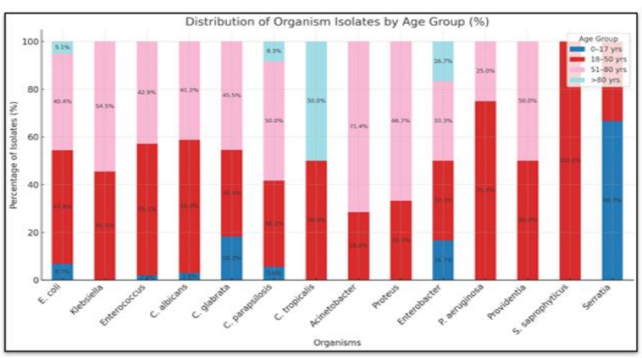

Figure 5: Distribution of isolates age wise analysis

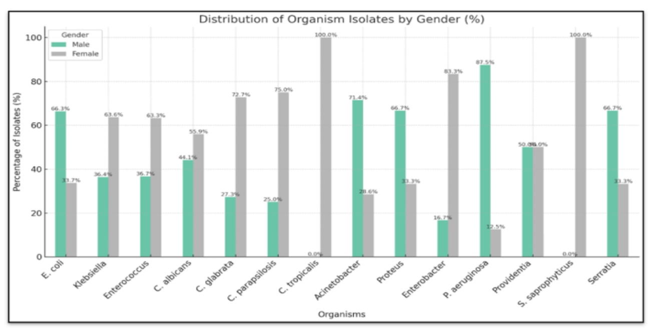

Figure 6: Distribution of isolates gender wise analysis

In the age-wise analysis, *Escherichia coli* was the most common isolate (178; 44.8%), predominantly in the 18–50 years (21.4%) and 51–80 years (18.1%) groups, with a significant association between age and *E. coli* isolation (χ^2=18.34, df=3, p=0.001). Other organisms include *Klebsiella pneumoniae* (11.1%) and *Enterococcus spp*. (12.3%), *Candida* species were mainly observed in adults, with a few isolates among children and older people.

Table 4: Age wise analysis of *E coli* isolates

Organism	0–17 yrs n (%)	18–50 yrs n (%)	51–80 yrs n (%)	>80 yrs n (%)	Total n (%)	Chi-square (χ^2), df	p-value
Escherichia coli (E. coli)	12 (3.0%)	85 (21.4%)	72 (18.1%)	9 (2.3%)	178 (44.8%)	χ^2=18.34, df=3	0.001

Table 5: Gender wise analysis of *E coli* isolates

Organism	Male n (%)	Female n (%)	Total n (%)	Chi-square (χ^2), df	p-value
Escherichia coli (E. coli)	118 (29.7%)	60 (15.1%)	178 (44.8%)	χ^2=16.27, df=1	0.001

In the gender-wise comparison, *E.coli* was again predominant (44.8%), occurring more in females (29.7%) than in males (15.1%), with statistical significance (χ^2=16.27, df=1, p=0.001). *Klebsiella pneumoniae, Enterococcus spp*., and *Candida* species showed relatively higher proportions among females, while *Pseudomonas aeruginosa* was more frequent in males.

Table 6: E. coli Antibiotic susceptibility pattern

Antibiotic	Sensitivity (%)	Antibiotic	Sensitivity (%)
Ceftazidime	11.2	Netilmicin	4.4
Cefuroxime	6	Tetracycline	19
Cefotaxime	7	Piperacillin–Tazobactam	36.5
Cefepime	7.8	Ticarcillin–Clavulanate	26.9
Ceftriaxone	6	Imipenem	42
Ampicillin	6	Meropenem	46
Amoxicillin–Clavulanate	15.7	Ertapenem	48
Ampicillin–Sulbactam	11.2	Polymyxin B	100
Norfloxacin	12	Colistin	100
Ofloxacin	1	Fosfomycin	62
Levofloxacin	8.9	Nitrofurantoin	50
Amikacin	37	Co-trimoxazole	29
Tobramycin	20	Chloramphenicol	36

Of the 178 *E. coli* isolated, the highest susceptibility was seen in Fosfomycin (62%), followed by Nitrofurantoin (49%), Carbapenems (approximately 45%), Amikacin (37%), Chloramphenicol (36%), and Co-trimoxazole (29%). An overall high level of resistance was observed in fluoroquinolones (approximately 7%) and Cephalosporins (approximately 10%).

Discussion

Urinary tract infections (UTIs) are among the most common infections found worldwide, and the current study highlights the ongoing threat of antimicrobial resistance and the challenges that might be faced in treating such diseases. A multicentric study conducted from 1990 to 2019 has shown a significant increase in the global burden of UTI and mortality rates associated with the rising antimicrobial-resistant organisms.[12] The prevalence of UTI in the northern region has been seen between 10% to 17%.[13] The prevalence of UTI in our study was 13% consistent with these findings. However, most studies around Uttar Pradesh have shown much higher prevalence rates. [14,15]

Uropathogens were higher in number in females (63%) than in males (37%). The distribution was found to be statistically significant in *E. coli* isolates. According to multiple studies, the incidence of UTIs has been higher in females than in males. [15,16] The anatomy of the female urethra, along with some urological factors such as urinary incontinence, sexual intercourse, and poor personal or toiletry hygiene, may contribute to a higher rate of UTI in females. [17]

UTI cases were more prevalent in the patients' age group, ranging from 20 to 45 years (47%), which is comparable to some studies. [16,18] This is also the reproductive age seen in females, highlighting this as an important risk factor for UTIs in young females.

The most common organism isolated in the study was *Escherichia coli (E. coli),* 54% in OPD patients and 42% in IPD patients. The findings are similar to various studies in and outside India.[13,15,16,19] Enterobacteriaceae family in UTIs can be linked to their classic morphological factors like pili, fimbriae, adhesins, and p1 blood group receptors, aiding in their colonization and the ability to adhere to the urinary bladder epithelium.[17] The second most common organism isolated was *Enterococcus* species (n=89; 12.2 % in OPD and n=308; 12.3% in IPD), the finding being consistent with studies from north and south India.[13,19] Other bacterial isolates obtained in the survey were *Klebsiella pneumoniae, Candida species, Pseudomonas sp., Acinetobacter sp., Proteus sp., Providentia sp., Enterobacter sp., and Staphylococcus saprophyticus* (CONS). Amongst the isolated organisms, *Candida* species was found to be in higher numbers in IPD patients (OPD- 12%; IPD- 15%), suggesting its pronounced association in hospital-acquired infections or antecedent use of catheters/devices leading to device-associated infections or catheter-associated UTIs (CAUTI). Similar observations have been noted in a study from Uttar Pradesh.[13]

Of the total 178 *E. coli* isolated, the highest susceptibility was seen in Fosfomycin (62%), followed by Nitrofurantoin (50%), Carbapenems (approximately 45%), Amikacin (37%), Chloramphenicol (36%), and Co-trimoxazole (29%). These antibiotics could be more beneficial in treating UTIs in the current setting as the first line of management, except for restricting the use of Carbapenems. However, they are observed to be moderately sensitive (~ 45%), as they are classified under the reserved group category in WHO's AWaRe classification of antimicrobials. Nitrofurantoin susceptibility is comparable to various studies.[20–22] Many previous studies from India have shown that Nitrofurantoin and Fosfomycin are good initial treatment options.[17,23,24] Higher susceptibility to Nitrofurantoin may be attributable to its restricted use for acute cystitis, narrow tissue distribution and spectrum of action, small serum concentration, and bactericidal action against *E.coli* at therapeutic doses.[25] Fosfomycin is also a good oral treatment option for both *E.coli* and *Enterococcus* spp. as causative agents of acute uncomplicated cystitis.[23] Fosfomycin, which was not marketed much in India before, was notably recommended as the first line of management for UTI in guidelines given by ICMR in 2022.[26]

Chromphenicol sensitivity was typically found to be more than anticipated. In *E.coli*, it was found to be 36% and approximately 40% sensitive to other isolates. Similar studies have reported decreasing resistance to chloramphenicol over the years.[27] There could be several reasons for the same: its restricted use over time due to its propensity to cause adverse hematological effects, and a change in clinical practice to use it as a targeted therapy. However, the rising susceptibility does not warrant its use as a first-line drug for UTIs, mainly due to its known toxic side effects. Still, it may be considered in treating uropathogens showing multidrug resistance or serious UTIs.

Overall, a high level of resistance was observed in Fluoroquinolones and Cephalosporins (for *E.coli*, Ciprofloxacin sensitivity was 7% and the cephalosporin group approximately 10%) . Various other studies have shown increasing resistance to Fluoroquinolones, which probably can be linked to their increased use as prophylactic management for uncomplicated UTIs or as empirical therapy for cases without performing culture sensitivity of the samples. [19] Also, high resistance to Cephalosporins has been reported by multiple studies. [17,19,20] Hence, using Ciprofloxacin for UTIs may wane off in the coming years. In a country like India, such high resistance could be attributed to several factors, such as over-the-counter use of antibiotics without proper prescriptions, non-compliance with medications, lack of implementation of antimicrobial stewardship programs, or understanding of antimicrobial patterns in a specific region. Lastly, the lack of a culture of sending microbial cultures leads to erroneous or poor prescriptions, worsening the situation even more. Overall, high sensitivity was observed for Amikacin in Enterobacteriaceae and *Acinetobacter spp*. isolates, which is consistent with the findings in a study from Kolkata (11%) and a multi-regional study of India (7.2 %).[21,24]

Conclusion

The most common organism isolated in our setting was *E.coli*. Overall susceptibility pattern of uropathogen isolates showed a typical falling sensitivity in fluoroquinolones and the Cephalosporins group of antibiotics, and better susceptibility patterns for Fosfomycin, Nitrofurantoin, Carbapenems, and Aminoglycosides. The study explains the antibiogram of common isolates that might help treating physicians choose appropriate empirical treatment. The current study also highlights the importance of performing urine cultures to provide targeted therapy jointly to avoid worsening impending antimicrobial resistance. Lack of microbiological testing in many cities of India leads to no data on antibiograms or knowledge of common pathogens in those regions. This, along with irrational treatments and resistance to urinary pathogens, remains a major public health challenge for India. An effort should be made to address this challenge in the future.

Limitations of the Study

Sample screening was not done symptom-based, which could've given a better clinical insight. Device use was not recorded, which might have helped in understanding the burden of hospital-acquired infections more clearly.

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Conflicts of interest

There are no conflicts of interest.

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