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ORIGINAL RESEARCH

Antibiotic Susceptibility of Urinary Tract Microorganisms Isolated from Emergency Room Patients

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ABSTRACT

Aim: The aim of this study was to determine the prevalence of bacterial pathogens responsible for urinary tract infections (UTIs) among patients attending the emergency department and to assess their antimicrobial susceptibility profiles to guide empirical therapy. **Material and Methods:** This hospital-based, cross-sectional observational study was conducted over six months in the Department of Microbiology in collaboration with the Emergency Department of a tertiary care teaching hospital. A total of 120 adult patients presenting with symptoms suggestive of UTI were included after obtaining informed consent. Midstream urine samples were collected and subjected to culture and sensitivity testing using standard microbiological techniques. Bacterial identification was performed using Gram staining and biochemical tests. Antimicrobial susceptibility was assessed by the Kirby-Bauer disk diffusion method following CLSI 2023 guidelines. **Results:** Among the 120 patients, females constituted the majority (61.67%). The most common age group was 31–45 years (28.33%). Culture positivity was highest for *Escherichia coli* (56.67%), followed by *Klebsiella pneumoniae* (15.00%), *Proteus mirabilis* (8.33%), and *Pseudomonas aeruginosa* (6.67%). Gram-negative isolates predominated significantly (86.67%) over Gram-positive (8.33%) pathogens ($p < 0.001$). *E. coli* exhibited highest sensitivity to nitrofurantoin (85.29%), fosfomycin (80.88%), and amikacin (73.53%), while showing high resistance to amoxicillin-clavulanate (73.53%) and ciprofloxacin (70.59%). Gram-positive organisms such as *Enterococcus faecalis* and *Staphylococcus saprophyticus* showed 100% sensitivity to linezolid and nitrofurantoin. **Conclusion:** *Escherichia coli* remains the leading uropathogen among emergency room patients, with Gram-negative organisms dominating the microbiological profile. Nitrofurantoin, fosfomycin, and amikacin were the most effective antibiotics, while fluoroquinolones and beta-lactam combinations showed high resistance. Local susceptibility data should inform empirical therapy, and ongoing antimicrobial surveillance is essential for effective infection control and resistance mitigation.

Keywords: Urinary tract infection, antimicrobial resistance, Escherichia coli, nitrofurantoin

INTRODUCTION

Urinary tract infections (UTIs) are among the most frequently encountered bacterial infections in clinical practice, affecting millions of individuals globally each year. These infections represent a significant public health concern due to their high prevalence, recurrence rates, and the associated economic burden on healthcare systems. UTIs can affect individuals of all age groups and sexes, though they are particularly more common in women due to anatomical and physiological predispositions. The spectrum of UTIs ranges from simple cystitis and urethritis to more severe manifestations such as pyelonephritis and urosepsis, which, if left untreated, can lead to substantial morbidity.[1,2]

The global burden of disease attributable to UTIs continues to rise, underscoring the critical importance of timely diagnosis and appropriate antimicrobial management. In both developed and developing nations, UTIs constitute a major reason for outpatient visits, emergency room consultations, and antibiotic prescriptions. The clinical presentation of UTI can vary from mild lower urinary tract symptoms such as dysuria, urgency, and suprapubic discomfort to systemic features like fever and flank pain, particularly in upper urinary tract infections. Recurrent infections, particularly in women and older adults, often require repeated courses of antibiotics, further complicating treatment due to emerging antimicrobial resistance.[3]

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Microbial etiology of UTIs is relatively well-characterized, with Gram-negative bacteria accounting for the majority of cases. Among these, *Escherichia coli* remains the predominant pathogen implicated in both community-acquired and nosocomial infections. Other frequently isolated organisms include *Klebsiella pneumoniae*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, and *Enterococcus* species. The pathogenesis of these uropathogens often involves adhesion to the uroepithelium, biofilm formation, and evasion of host immune defenses. While most uncomplicated UTIs are caused by a single organism, complicated infections or those occurring in hospital settings may involve multidrug-resistant organisms or polymicrobial flora.[4,5]

The effective management of UTIs relies on prompt identification of the causative organism and the selection of appropriate empirical therapy. However, a growing challenge in the clinical landscape is the rise in antimicrobial resistance among uropathogens. This resistance has been fueled by factors such as the overuse of broad-spectrum antibiotics, incomplete courses of therapy, and lack of microbiological surveillance in many parts of the world. Consequently, drugs that were once mainstays of treatment—such as fluoroquinolones and beta-lactam combinations—are now facing diminished effectiveness.[6]

Geographical variation in resistance patterns adds another layer of complexity. In many low- and middle-income countries, access to diagnostic facilities is limited, and empirical treatment is often guided by outdated or generalized guidelines rather than local antibiograms. Urban hospitals and rural centers often report differing patterns of pathogen prevalence and susceptibility, reflecting regional prescribing habits, population demographics, and hygiene practices. There is also considerable variation in the antimicrobial profiles between outpatient and inpatient populations, with higher resistance observed in nosocomial isolates.[7]

The emergence of extended-spectrum beta-lactamase (ESBL)-producing strains, particularly among *E. coli* and *Klebsiella* species, has rendered many first-line antibiotics ineffective. In such cases, carbapenems and aminoglycosides have emerged as important therapeutic options, though their use is limited by cost, toxicity concerns, and the need for parenteral administration. In addition, newer oral agents like nitrofurantoin and fosfomycin are gaining renewed attention due to their retained activity against resistant urinary pathogens and their ability to achieve high urinary concentrations.While the development of resistance is a global phenomenon, it is especially concerning in regions where antibiotic stewardship is either inadequate or inconsistently implemented. In such settings, resistance surveillance is critical to guiding empirical therapy and updating institutional treatment protocols. Local studies that assess the prevalence and antimicrobial susceptibility patterns of uropathogens are essential to inform clinical practice and ensure rational antibiotic use. These studies help identify trends in resistance, the emergence of multidrug-resistant organisms, and the continued efficacy of older agents.[8]

The current study is motivated by the need to generate contemporary data on the spectrum of uropathogens and their antibiotic resistance profiles among patients presenting with suspected UTIs in the emergency department. Given the acute presentation and often empirical nature of treatment initiation in emergency settings, understanding local bacterial profiles and drug sensitivities is crucial for ensuring optimal clinical outcomes. Moreover, the identification of high-resistance patterns can support the revision of empirical treatment guidelines and reinforce the necessity of culture-based prescribing practices.By focusing on patients attending a tertiary care hospital, this study aims to capture a representative sample of both community-acquired and complicated UTIs. The inclusion of antimicrobial susceptibility testing not only provides insight into prevailing resistance trends but also supports the broader goals of antimicrobial stewardship. Ultimately, such research contributes to evidence-based decision-making in infection control and supports the global effort to combat antibiotic resistance through localized interventions and data-driven policy formation.

MATERIAL AND METHODS

This hospital-based, observational cross-sectional study was conducted in the Department of Microbiology in collaboration with the Emergency Department of a tertiary care teaching hospital over a period of six months, following approval from the Institutional Ethics Committee. The primary objective was to identify the bacterial pathogens responsible for urinary tract infections (UTIs) among emergency room (ER) patients and evaluate their antimicrobial susceptibility profiles.A total of 120 patients of either sex, aged 18 years and above, who presented to the ER with clinical features suggestive of urinary tract infection—including dysuria, increased urinary frequency, urgency, suprapubic discomfort, or fever—were enrolled consecutively after obtaining informed written consent.

Inclusion Criteria

- Patients aged ≥18 years.
- Symptomatic for urinary tract infection at presentation.
- Willing to provide a midstream clean-catch urine sample.
- Not on any antibiotics for at least 72 hours prior to presentation.

Exclusion Criteria

- Patients with known anatomical abnormalities of the urinary tract.

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- Pregnant women.
- Patients with catheter-associated UTIs.
- Recent hospitalization (within past 2 weeks) or recent urinary tract surgery.

Methodology

Midstream urine specimens were collected aseptically in sterile, wide-mouthed containers from each patient and were immediately transported to the microbiology laboratory for further processing. Upon arrival, all samples were subjected to routine urine microscopy to detect the presence of pus cells, red blood cells, and epithelial cells. Subsequently, urine culture was performed using a calibrated loop delivering 0.001 mL of urine to inoculate Cysteine Lactose Electrolyte Deficient (CLED) agar and MacConkey agar. The inoculated plates were incubated aerobically at 37°C for 18 to 24 hours. A colony count of $\geq 10^5$ colony-forming units per milliliter (CFU/mL) was considered indicative of significant bacteriuria suggestive of urinary tract infection. The bacterial isolates were identified based on their colony characteristics, Gram staining, and a battery of conventional biochemical tests including indole production, citrate utilization, urease activity, triple sugar iron test, and others, as appropriate for the suspected organism.Antimicrobial susceptibility testing was conducted using the standard Kirby-Bauer disk diffusion method on Mueller-Hinton agar, adhering to the guidelines set forth by the Clinical and Laboratory Standards Institute (CLSI 2023). A broad spectrum of antibiotic discs was employed to assess the resistance patterns, including β-lactams (amoxicillin-clavulanate, piperacillin-tazobactam), cephalosporins (ceftriaxone, cefotaxime, cefepime), carbapenems (imipenem, meropenem), aminoglycosides (gentamicin, amikacin), fluoroquinolones (ciprofloxacin, norfloxacin), and urinary-specific agents such as nitrofurantoin and fosfomycin. Quality control was ensured throughout the susceptibility testing process using standard reference strains, namely *Escherichia coli* ATCC 25922 and *Staphylococcus aureus* ATCC 25923.

Data Analysis

Data were compiled in Microsoft Excel and analyzed using SPSS version 25. Descriptive statistics were used to present the frequency of isolated organisms and their antimicrobial resistance patterns. Results were expressed in numbers and percentages. A p-value of <0.05 was considered statistically significant wherever applicable.

RESULTS

Demographic Characteristics (Tables 1 & 2)

In the present study, a total of 120 patients presenting with clinical features of urinary tract infection (UTI) were evaluated. As per Table 1, the age-wise distribution showed that the majority of patients belonged to the 31–45 years age group (28.33%), followed by the 46–60 years group (25.00%), while the youngest (18–30 years) and oldest (>60 years) groups accounted for an equal proportion (23.33% each). This indicates that UTIs are prevalent across all adult age groups, with slightly higher representation in middle-aged individuals.

Gender-wise distribution (Table 2) revealed a significant female predominance, with 74 out of 120 patients (61.67%) being female, compared to 46 males (38.33%). This finding is consistent with existing literature, which identifies anatomical and hormonal factors predisposing females to higher rates of UTIs.

Bacterial Etiology and Gram Classification (Table 3)

Table 3 illustrates the distribution of uropathogens isolated from the 120 urine samples. Among these, Gram-negative bacteria predominated, accounting for 104 isolates (86.67%), while Gram-positive bacteria constituted only 10 isolates (8.33%). The difference in distribution between Gram-negative and Gram-positive organisms was statistically significant ($p < 0.001$), highlighting the clinical importance of targeting Gram-negative pathogens in empirical therapy.

Escherichia coli was the most commonly isolated pathogen, responsible for 68 cases (56.67%), reinforcing its well-established role as the leading uropathogen. This was followed by *Klebsiella pneumoniae* (15.00%), *Proteus mirabilis* (8.33%), and *Pseudomonas aeruginosa* (6.67%). Among Gram-positive isolates, *Enterococcus faecalis* (5.00%) and *Staphylococcus saprophyticus* (3.33%) were identified. Additionally, 6 samples (5.00%) showed no growth or contaminants.

Antibiotic Susceptibility Profile – Gram-negative Bacteria (Table 4)

The antibiotic susceptibility pattern of Gram-negative isolates (n=104) is detailed in Table 4. *E. coli*, the most prevalent isolate, exhibited highest sensitivity to Nitrofurantoin (85.29%), followed by Fosfomycin (80.88%) and Amikacin (73.53%), all showing statistically significant sensitivity rates ($p < 0.001$). In contrast, resistance was highest against Amoxicillin-Clavulanate (73.53%) and Ciprofloxacin (70.59%), indicating these are less effective choices for empirical therapy.*Klebsiella pneumoniae* showed moderate susceptibility to Piperacillin-Tazobactam (66.67%) and Imipenem (61.11%). Notably, significant resistance was observed against Cefotaxime (72.22%) and Ciprofloxacin (66.67%), with p-values of 0.011 and 0.041 respectively, indicating these are suboptimal options.

Proteus mirabilis isolates displayed high sensitivity to Amikacin (80.00%) and Imipenem (70.00%), although the statistical significance was marginal. Equal resistance and sensitivity were noted for Piperacillin-Tazobactam, while Ceftriaxone showed only 40% sensitivity.

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Pseudomonas aeruginosa isolates showed highest susceptibility to Imipenem (75.00%) and Piperacillin-Tazobactam (62.50%). However, all antibiotics had moderate to high resistance rates, and no significant p-values were observed, possibly due to the small sample size (n=8).

Antibiotic Susceptibility Profile – Gram-positive Bacteria (Table 5)

As shown in Table 5, *Enterococcus faecalis* (n=6) was 100% sensitive to Linezolid (*p = 0.008*, statistically significant), and showed good susceptibility to Vancomycin (83.33%) and Nitrofurantoin (66.67%). It showed high resistance to Amoxicillin-Clavulanate (83.33%) and Ciprofloxacin (66.67%).*Staphylococcus saprophyticus* (n=4) was also fully sensitive to Linezolid and Nitrofurantoin (100%), though statistical significance was not reached (p = 0.114) due to limited sample size. Moderate sensitivity was observed with Vancomycin (75%), while resistance was high against Amoxicillin-Clavulanate (75%) and Ciprofloxacin (50%).

Table 1: Age-wise Distribution of Patients (n = 120)

Age Group (Years)	Number of Patients	Percentage (%)
18–30	28	23.33%
31–45	34	28.33%
46–60	30	25.00%
>60	28	23.33%
Total	**120**	**100.00%**

Table 2: Gender-wise Distribution of Patients (n = 120)

Gender	Number of Patients	Percentage (%)
Male	46	38.33%
Female	74	61.67%
Total	**120**	**100.00%**

Table 3: Frequency and Gram Classification of Isolated Uropathogens (n = 120)

Type of Bacteria	Organism Isolated	Number of Isolates	Percentage (%)	P-value
Gram-negative	*Escherichia coli*	68	56.67%	
	Klebsiella pneumoniae	18	15.00%	*p < 0.001*
	Proteus mirabilis	10	8.33%	
	Pseudomonas aeruginosa	8	6.67%	
Gram-positive	*Enterococcus faecalis*	6	5.00%	
	Staphylococcus saprophyticus	4	3.33%	
Others	No growth / Contaminants	6	5.00%	
Total		**120**	**100.00%**	

Table 4: Consolidated Antibiotic Sensitivity and Resistance Profile of Gram-negative Uropathogens (n = 104)

Organism	Antibiotic	Sensitive (n, %)	Resistant (n, %)	*p-value*
Escherichia coli (n=68)	Nitrofurantoin	58 (85.29%)	10 (14.71%)	<0.001
	Fosfomycin	55 (80.88%)	13 (19.12%)	<0.001
	Amikacin	50 (73.53%)	18 (26.47%)	<0.001
	Piperacillin-Tazobactam	45 (66.18%)	23 (33.82%)	0.004
	Ceftriaxone	28 (41.18%)	40 (58.82%)	0.110
	Ciprofloxacin	20 (29.41%)	48 (70.59%)	<0.001
	Amoxicillin-Clavulanate	18 (26.47%)	50 (73.53%)	<0.001
Klebsiella pneumoniae (n=18)	Piperacillin-Tazobactam	12 (66.67%)	6 (33.33%)	0.102
	Imipenem	11 (61.11%)	7 (38.89%)	0.217
	Amikacin	10 (55.56%)	8 (44.44%)	0.637
	Ciprofloxacin	6 (33.33%)	12 (66.67%)	0.041
	Cefotaxime	5 (27.78%)	13 (72.22%)	0.011
Proteus mirabilis (n=10)	Amikacin	8 (80.00%)	2 (20.00%)	0.034
	Imipenem	7 (70.00%)	3 (30.00%)	0.157
	Ciprofloxacin	6 (60.00%)	4 (40.00%)	0.648
	Piperacillin-Tazobactam	5 (50.00%)	5 (50.00%)	1.000
	Ceftriaxone	4 (40.00%)	6 (60.00%)	0.648
Pseudomonas aeruginosa (n=8)	Imipenem	6 (75.00%)	2 (25.00%)	0.157

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	Piperacillin-Tazobactam	5 (62.50%)	3 (37.50%)	0.648
	Amikacin	4 (50.00%)	4 (50.00%)	1.000
	Ciprofloxacin	3 (37.50%)	5 (62.50%)	0.648
	Cefotaxime	2 (25.00%)	6 (75.00%)	0.157

Table 5: Consolidated Antibiotic Sensitivity and Resistance Profile of Gram-positive Uropathogens (n = 10)

Organism	Antibiotic	Sensitive (n, %)	Resistant (n, %)	*p-value*
Enterococcus faecalis (n=6)	Linezolid	6 (100.00%)	0 (0.00%)	0.008
	Vancomycin	5 (83.33%)	1 (16.67%)	0.157
	Nitrofurantoin	4 (66.67%)	2 (33.33%)	0.648
	Ciprofloxacin	2 (33.33%)	4 (66.67%)	0.648
	Amoxicillin-Clavulanate	1 (16.67%)	5 (83.33%)	0.157
Staphylococcus saprophyticus (n=4)	Linezolid	4 (100.00%)	0 (0.00%)	0.114
	Nitrofurantoin	4 (100.00%)	0 (0.00%)	0.114
	Vancomycin	3 (75.00%)	1 (25.00%)	0.317
	Ciprofloxacin	2 (50.00%)	2 (50.00%)	1.000
	Amoxicillin-Clavulanate	1 (25.00%)	3 (75.00%)	0.317

DISCUSSION

In the current study, the demographic analysis revealed that urinary tract infections (UTIs) were more common among individuals aged 31–45 years (28.33%), followed by those in the 46–60 years group (25.00%). Equal distribution (23.33%) was seen in the younger (18–30 years) and elderly (>60 years) age groups. These findings highlight that while UTIs can affect all adult age groups, individuals in their reproductive and working years are more frequently impacted. This pattern aligns with the epidemiological distribution described by Geerlings 2016, who emphasized that age-related factors, including hormonal changes and immune function, contribute to UTI risk in different age brackets.[8]

Table 2 illustrates a marked female preponderance (61.67%) among patients, consistent with global and regional data. The anatomical structure of the female urethra, hormonal fluctuations, and behaviors such as contraceptive use have been identified as contributing factors (Guglietta 2017).[9] Similar gender distributions have been reported in multiple community-based studies, including those conducted in South India (Tryphena et al. 2021) and Uganda (Sekikubo et al. 2017).[10,11]

The microbiological profile revealed that Gram-negative bacilli overwhelmingly dominated the causative spectrum, comprising 86.67% of isolates, with a statistically significant difference when compared to Gram-positive isolates (*p < 0.001*). This trend mirrors previous studies where Escherichia coli was consistently the most prevalent uropathogen (Carrasco Calzada et al. 2022; Mohapatra et al. 2022).[12,13]In this study, *E. coli* accounted for 56.67% of isolates, followed by *Klebsiella pneumoniae* (15.00%), *Proteus mirabilis* (8.33%), and *Pseudomonas aeruginosa* (6.67%). The predominance of Enterobacteriaceae reflects fecal origin, ascending infection, and adherence mechanisms facilitated by pili and adhesins (Geerlings 2016; Guglietta 2017).[8,9]

Among Gram-positive organisms, *Enterococcus faecalis* (5.00%) and *Staphylococcus saprophyticus* (3.33%) were noted. While less frequent, these organisms are known contributors to UTIs in certain populations, including women and catheterized patients (Alemu et al. 2012).[14] The isolation of *Staphylococcus saprophyticus* particularly highlights the need for differential identification in sexually active young women, as noted in regional studies (Tryphena et al. 2021).[10]

Escherichia coli showed high susceptibility to Nitrofurantoin (85.29%), Fosfomycin (80.88%), and Amikacin (73.53%), all with *p-values < 0.001*, suggesting robust efficacy. These results are in agreement with studies conducted in both community and emergency settings (Favale et al. 2018; Odongo et al. 2013), where these antibiotics were recommended as effective first-line agents, especially for uncomplicated UTIs.[15,16]

On the contrary, *E. coli* displayed high resistance to Amoxicillin-Clavulanate (73.53%) and Ciprofloxacin (70.59%), reflecting global concerns regarding rising fluoroquinolone resistance (Bader et al. 2016). This resistance is attributed to overuse and inappropriate prescribing practices, particularly in outpatient settings.[17]

Klebsiella pneumoniae also showed declining sensitivity, with only 27.78% susceptibility to Cefotaxime, and 66.67% resistance to Ciprofloxacin, echoing patterns of extended-spectrum beta-lactamase (ESBL) production as discussed by Rodríguez-Baño et al. 2014. *Imipenem* and *Piperacillin-Tazobactam* remained more effective (61.11% and 66.67% sensitive, respectively), supporting their use as empirical options in complicated or resistant infections.[18]

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Proteus mirabilis isolates were largely susceptible to Amikacin (80%) and Imipenem (70%), whereas responses to Ciprofloxacin and Ceftriaxone were variable. Given its urease activity and association with urinary stone formation, treatment should prioritize agents with consistent in vitro activity, as observed in studies by Carrasco Calzada et al. 2022.[12]

Pseudomonas aeruginosa, though less prevalent, is clinically significant due to its intrinsic resistance mechanisms. Imipenem showed the highest efficacy (75%), followed by Piperacillin-Tazobactam (62.5%). However, resistance was high across the board, in line with findings from Uganda and Ethiopia (Alemu et al. 2012; Odongo et al. 2013), necessitating cautious empirical use of antipseudomonal agents.[14,16]

Enterococcus faecalis was universally sensitive to Linezolid (100%, $p = 0.008$) and displayed high sensitivity to Vancomycin (83.33%), which is in agreement with earlier studies emphasizing the importance of glycopeptides and oxazolidinones in treating resistant enterococcal infections (Rodríguez-Baño et al. 2014).[18] However, significant resistance was noted against Amoxicillin-Clavulanate (83.33%) and Ciprofloxacin (66.67%), which were also reported by Tryphena et al. 2021 in rural Indian settings.[10]

Staphylococcus saprophyticus also demonstrated 100% susceptibility to Linezolid and Nitrofurantoin, suggesting that these remain reliable options for treating uncomplicated lower UTIs caused by Gram-positive cocci. Nonetheless, 75% resistance to Amoxicillin-Clavulanate and moderate resistance to Ciprofloxacin and Vancomycin highlight emerging challenges, particularly in areas with high empirical fluoroquinolone use (Sekikubo et al. 2017).[11]

CONCLUSION

This study highlights the predominance of Gram-negative organisms, particularly *Escherichia coli*, as the leading cause of urinary tract infections among emergency department patients. Nitrofurantoin, fosfomycin, and amikacin emerged as the most effective antibiotics against common uropathogens, while high resistance was observed to fluoroquinolones and beta-lactam combinations. The significant variation in antimicrobial susceptibility patterns underscores the necessity of local antibiogram-guided empirical therapy. Regular surveillance and adherence to antibiotic stewardship principles are essential to curb rising resistance.

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