Original Article

Rising Antimicrobial Resistance in Urinary Tract Infections in Bangladesh: A Microbiological Analysis

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ABSTRACT

Background: Antimicrobial resistance (AMR) in urinary tract infections (UTIs) is a growing global health issue, complicating treatment strategies and increasing healthcare burdens. **Aim:** This study aims to analyze the microbiological profile of UTIs and evaluate resistance patterns of uropathogens across different antimicrobial agents. **Materials and Methods:** This retrospective, observational study was carried out in Mount Adora Hospital, Akhalia, Sylhet. Data record were reviewed from July 1st, 2023 to February 29th 2024 and all the urine culture-positive reports were collected with the organism isolated and their antibiotic resistance to different organisms. **Results:** This study included 783 UTI patients, with a male-to-female ratio of 1:2.16 and a mean age of 52.82 years. *Escherichia coli* was the most common uropathogen (54.5%), followed by *Klebsiella sp.* (20.4%) and *Pseudomonas sp*. (11.6%). High resistance was observed against Azithromycin (80.9%), Nalidixic Acid (79.1%) and Cefixime (78.3). Among injectables, Tigecycline (4.3%), Imipenem (13.4%), and Colistin (15.1%) showed the lowest resistance. **Conclusion:** The study demonstrates significant rise in antimicrobial resistance in UTIs in Bangladesh, particularly against commonly used antibiotics.

Keywords: Urinary tract infection, antimicrobial resistance, uropathogens, MDR, XDR.

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Introduction

Urinary tract infections (UTIs) are the most frequent bacterial infections encountered in clinical practice, particularly affecting women, the elderly, and immunocompromised individuals.[1] It is estimated that over 150 million people worldwide experience UTIs each year, leading to significant healthcare burdens and economic costs.[2] The rising prevalence of antimicrobial resistance (AMR) in uropathogens presents a significant challenge to effective treatment. Multidrug-resistant (MDR) bacteria are increasingly limiting therapeutic options, rendering many first-line antibiotics ineffective and leading to prolonged illness, higher morbidity, and increased healthcare costs.[3,4] UTIs range from uncomplicated lower UTIs to pyelonephritis, which may result in sepsis and renal damage.[5]

While UTIs are common in both high-income and low- and middle-income countries (LMICs), the burden of AMR is disproportionately rising

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in LMICs, including Bangladesh. [6,7] Factors such as antibiotic misuse, injudicious prescribing, inadequate diagnostic facilities, and the widespread availability of antibiotics without prescriptions contribute to the acceleration of resistance.[8,9] Self-medication, often for conditions that do not require antibiotics, further exacerbates the problem.[10] Moreover, the extensive use of antibiotics in poultry farms and fisheries significantly contributes to the development of antimicrobial resistance.[11]

Globally, *Escherichia coli* remains the predominant uropathogen, followed by *Klebsiella spp.*, *Enterococcus spp.*, *Proteus spp.*, and *Pseudomonas aeruginosa*, with Gram-negative bacteria accounting for the majority of UTIs.[4,5] Increasing resistance among these organisms—particularly to fluoroquinolones, third-generation cephalosporins, and cotrimoxazole—has been widely documented, leading to a growing burden of multidrug-resistant (MDR) infections.[4] Studies from Bangladesh demonstrate a similar microbiological profile, with *E. coli* consistently identified as the most common causative agent of UTIs, followed by *Klebsiella spp.*[7,8] These findings reflect the broader challenges of antimicrobial resistance observed in low- and middle-income countries, where antibiotic availability and consumption are often poorly regulated.[6]

Despite multiple reports highlighting rising antimicrobial resistance in UTIs across Bangladesh, regional data remain limited, and resistance patterns vary between healthcare settings. This study aims to identify the common bacterial pathogens causing UTIs and their antimicrobial susceptibility patterns in a Bangladeshi clinical setting to guide empirical therapy and support antibiotic stewardship.

Methods and Materials:

This retrospective observational study was conducted in the Mount Adora Hospital, Sylhet, Bangladesh, from July 1, 2023, to February 29, 2024. Mount Adora Hospital is a private facility with a microbiology laboratory accredited under ISO 9001:2015. Patients presenting with clinical features suggestive of urinary tract infection (UTI) and a positive urine culture ($\geq 10^5$ CFU/mL of a single pathogen) were included. Exclusion criteria were patients with incomplete records, prior antibiotic use within 72 hours of urine collection, or contaminated/mixed growth cultures.

We also categorized antimicrobial resistance patterns as MDR and XDR, where multi-drug-resistant (MDR) organisms are defined as resistant to at least one agent in three or more antimicrobial categories. Extensively drug-resistant (XDR) organisms are defined as isolates that are susceptible to only one or two antimicrobial classes, with resistance to agents in all other categories.[2]

Demographic details, clinical information, isolated pathogens, and antibiotic susceptibility profiles were retrieved from hospital records and laboratory databases. Data were compiled and analyzed using SPSS version 27.0. Continuous variables were summarized as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. All data were obtained from routine clinical services through non-invasive record review. Patient confidentiality was maintained by removing personal identifiers.

Results:

A total of 783 patients with UTIs were included in the study, of whom 248 (32%) were male and 535 (68%) were female, resulting in a 1:2.16 male-to-female ratio. The mean age was 52.82 years (SD 22.51), ranging from 28 days to 105 years. Age distribution showed that 10% of the patients were 0-20 years old, 16% were 21-40 years old, 32.3% were 41-60 years old, 34.7% were 61-80 years old, 6.9% were 81-100 years old, and 0.1% were over 101 years old. [Table 1].

Table 2 presents the distribution of isolated uropathogens. The most commonly identified pathogen was *Escherichia coli*, found in 427 (54.5%) of cultures, followed by *Klebsiella sp*. (160, 20.4%), *Pseudomonas sp*. (91, 11.6%), *Staphylococcus sp*. (59, 7.5%), *Streptococcus sp.* (30, 3.8%), *Enterococcus sp*. (11, 1.4%), Fungus (4, 0.5%), and *Proteus sp*. (1, 0.1%).

Among injectable antibiotics, tigecycline (4.3%) exhibited the lowest resistance, followed by imipenem (13.4%) and colistin (15.1%). Among oral antibiotics, Doxycycline (32.7%) and Nitrofurantoin (40.1%) showed the lowest resistance. Conversely, the most resistant injectable antibiotic was Linezolid (88.8%). Among oral antibiotics, Azithromycin (80.9%) and Nalidixic Acid (79.2%) had the highest resistance. High

resistance was also noted for β-lactam antibiotics such as Amoxicillin (65.1%), Ceftriaxone (61.7%), and Ceftazidime (65.6%), limiting the empirical use of these agents in UTIs. [Table 3]

Table 4 highlights the prevalence of multidrug-resistant (MDR) and extensively drug-resistant (XDR) organisms. The findings reveal a high burden of MDR, with 717 (91.6%) of the total isolates being MDR. Among *Escherichia coli* isolates, 410 (96%) showed multidrug resistance, followed closely by *Streptococcus sp.* at 96.7%, *Klebsiella sp.* at 91.2%, *Enterococcus sp.* at 91%, *Staphylococcus sp.* at 89.8%, and *Pseudomonas sp.* at 74.7%. A total of 2 XDR organisms (0.26%) were identified, with 1 in *Staphylococcus sp.* and 1 in *Enterococcus sp.*

Table 1: Demographic Characteristics of the study participants

Characteristics		No. of cases (%)
Patient age categories (years)	0-20	78 (10%)
	21-40	125 (16%)
	41-60	253 (32.3%)
	61-80	272 (34.7%)
	81-100	54 (6.9%)
	101+	1 (0.1%)
Gender Distribution	Male	248 (32%)
	Female	535 (68%)
	Male:Female	1:2.16
Mean age (years, ± SD)	52.82 (±22.51)	

Table 2: Distribution of Uropathogens

Organism Isolated	Frequency (%)	Male (248)	Female (535)
Escherichia coli	427 (54.5%)	117 (27.4%)	310 (72.6%)
Klebsiella sp.	160 (20.4%)	49 (30.6%)	111 (69.4%)
Pseudomonas sp.	91 (11.6%)	46 (50.5%)	45 (49.5%)
Staphylococcus sp.	59 (7.5%)	20 (33.9%)	39 (66.1%)
Streptococcus sp.	30 (3.8%)	13 (43.3%)	17 (56.7%)
Enterococcus sp.	11 (1.4%)	0 (0%)	11 (100%)
Fungus	4 (0.5%)	2 (50%)	2 (50%)
Proteus sp.	1 (0.1%)	1 (100%)	0

Table 3: Antimicrobial sensitivity status of the organisms causing UTI

Antibiotic Group	Antibiotic	Resistant (%)	Sensitive (%)	Intermediate (%)
Penicillin	Amoxicillin	65.1	24.1	10.8
	Piperacillin-Tazobactam	28.6	71.4	0.0
Cephalosporin	Cefaclor	73.7	25.1	1.2
	Cefuroxime	66.2	31.2	2.7
	Ceftazidime	65.6	29.3	5.1
	Ceftriaxone	61.6	36.2	2.2
	Cefixime	78.3	19.6	2.1
Aminoglycoside	Amikacin	22.5	61.2	16.3
	Gentamicin	32.9	49.0	18.1
Tetracycline	Doxycycline	32.7	55.7	11.6
	Tigecycline	4.3	89.4	6.4
Macrolide	Azithromycin	80.9	10.5	8.6
Oxazolidinone	Linezolid	88.8	11.2	0.0
Fluroquinolone	Nalidixic Acid	79.1	18.2	2.7
	Ciprofloxacin	53.5	44.8	1.7
	Levofloxacin	48.4	46.9	4.7
Carbapenem	Imipenem	13.4	83.8	2.8
	Meropenem	18.0	79.6	2.3
Nitrofuran	Nitrofurantoin	40.1	52.3	7.6
Polymyxin	Colistin	15.1	84.7	0.1
Others	Vancomycin	60.0	40.0	0.0
	Fosfomycin	58.3	16.7	25.0

Table 4: Pattern of Antimicrobial Resistance in patients with UTI

AMR	Frequency, n (%)	*E.coli*, n=427	*Klebsiella sp.*, n=160	*Pseudomonas sp.*, n=91	*Staphylococcus sp.*, n=59	*Streptococcus sp.*, n=30	*Enterococcus sp.*, n=11	*Proteus sp., n=1*
MDR	717 (91.6%)	410 (96%)	146 (91.2%)	68 (74.7%)	53 (89.8%)	29 (96.7%)	10 (91%)	1 (100%)
XDR	2 (0.26%)	0	0	0	1 (1.7%)	0	1 (9%)	0

Discussion:

Nowadays, Urinary tract infection (UTI) is an emerging public health concern worldwide, where antimicrobial resistance (AMR) is rising at an alarming rate. This rise has exacerbated the challenge of treating UTIs, underscoring the need to understand local bacterial resistance patterns to develop effective treatment strategies.[12]

In our study, a higher incidence of UTI was noted in females, who are more frequently affected due to anatomical and hormonal factors, such as a shorter urethra and urinary tract changes during menstruation and pregnancy.[10,13] Regarding age distribution, the mean age of the participants was 52.82 years (SD ±22.51), with a range spanning from 28 days to 105 years. The age group most affected by UTIs in this study was 41-60 years, comprising 32.3% of patients, followed closely by those aged 61-80 years, accounting for 34.7%. The increased frequency of UTIs in the elderly has been attributed to multiple factors, including advanced age–related comorbidities, functional and anatomical urinary tract abnormalities, urinary retention, and frequent exposure to urinary catheterization and institutional care.[5]

Among the isolated uropathogens, the findings highlight the consistent dominance of *Escherichia coli* (E. coli) as the most common pathogen in UTI cases, consistent with other studies. [9,10] In our study, E. coli accounted for approximately 60% of UTI cases, similar to many studies, which reported prevalence of 64% and 58%, respectively.[14,15] *Klebsiella pneumonia* (20.4%) was the second most common pathogen, comparable with other studies, accounting for 19-22%.10,15,16 The third most prevalent organism was *Pseudomonas aeruginosa* (11.6%), reflecting global trends.[16,17]

A notable finding in our study was the presence of fungal pathogens in 0.5% of UTI cases, a relatively rare but significant finding. Fungal UTIs have been reported in various studies, but their prevalence is typically much lower, typically under 1%.[17]

The high prevalence of multidrug-resistant (MDR) organisms in this study highlights a growing public health concern, particularly with *Escherichia coli* and *Klebsiella sp.*, which showed MDR in 410 (96%) and 146 (91.2%) isolates, respectively. These multidrug resistance rates were substantially higher than previously reported: 63% of *Escherichia coli* isolates and 16.8% of *Klebsiella* spp. isolates. isolates. Isolates were identified as MDR.[18,19] The significant resistance observed in *Staphylococcus sp.*, *Streptococcus sp.*, and *Enterococcus sp.* further emphasizes the widespread nature of multidrug resistance.

In contrast, the detection of two cases of extensively drug-resistant (XDR) organisms—one in *Staphylococcus sp.* and one in *Enterococcus sp.*—is a matter of serious concern. XDR organisms are resistant to nearly all available antibiotics, underscoring the critical need for novel antimicrobial therapies.

In our study, resistance to cephalosporins was notably high, with ceftriaxone (61.6%) and ceftazidime (65.6%) demonstrating substantial resistance. Similar resistance to ceftriaxone (60%) has been reported previously.[15] However, resistance to cefixime (78.3%) in our study was higher than that reported in other regional studies, with 57% to 60% resistance rates.15,20 Additionally, resistance to cefuroxime (66.2%) was higher than previously reported studies (59% to 60%).[10,15]

Fluoroquinolones, such as Ciprofloxacin (53.5%) and Nalidixic Acid (79.2%), showed high resistance in our study. Ciprofloxacin's resistance is consistent with other studies from Bangladesh (54%).[10] Nalidixic Acid, due to its widespread resistance, is largely obsolete for treating UTIs. The increase in resistance to these antibiotics calls for careful monitoring and reconsideration of their role in UTI treatment.

In our study, Doxycycline exhibited a resistance rate of 32.7%, which is lower than many commonly prescribed antibiotics. Similar findings have been

reported in Bangladesh, with resistance rates ranging from 30% to 33%.[10,15] Globally, studies have reported relatively low Doxycycline resistance rates, ranging from 28% to 35%.[17] Nitrofurantoin (40.1%) also showed low resistance, making it an excellent empirical choice for UTI treatment.

Tigecycline (4.3%) and Colistin (15.1%) exhibited the lowest resistance rates, making them strong candidates for treating severe infections. However, Tigecycline has poor urinary excretion, whereas Colistin causes significant nephrotoxicity. Despite their high sensitivity, Tigecycline and Colistin cannot be preferred for the treatment of UTIs.

Among the Carbapenems, Imipenem (13.4%) and Meropenem (18%) stand out as effective options for treating complicated UTIs. This finding is consistent with studies from Bangladesh, which reported resistance to Imipenem ranging from 12% to 14%.[10,20] Globally, Imipenem is preferred for severe UTIs, with resistance rates typically below 15%.[15,17] However, as carbapenem resistance is emerging, it is crucial to preserve the efficacy of this antibiotic through controlled use.

Study Limitations

This study has some limitations, including a single-center design, which may not fully represent national trends. Additionally, molecular characterization of resistance genes was not performed, which could have provided deeper insights into the mechanisms of resistance.

Conclusion

This study highlights a significant rise in antimicrobial resistance (AMR) among urinary tract infection (UTI) pathogens in Bangladesh. The study also underscores concerning resistance patterns, particularly to frequently prescribed antibiotics such as Cefixime, Cefuroxime, and Ciprofloxacin. These findings highlight the urgent need for stronger infection control measures and updated treatment protocols to combat AMR effectively.

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