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Pattern Of Antibiotic Resistance In Urinary Tract Infections: Insights From A Tertiary Care Hospital In Bangladesh

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Abstract

Background: *Urinary tract infections (UTIs) are one of the most common bacterial infections, with increasing rates of antibiotic resistance complicating treatment. This study aimed to assess the prevalence and antibiotic resistance patterns of uropathogens in patients with UTIs at a tertiary care hospital in Bangladesh.*

Methods: *A cross-sectional, retrospective study was conducted from June, 2023 to July, 2024 involving 60 UTI patients. Clinical and microbiological data, including urine cultures and antibiotic susceptibility tests, were collected. Antibiotic susceptibility testing was performed using the Kirby-Bauer disk diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines. Data were analyzed using SPSS version 26.0.*

Results: *Escherichia coli was the most frequently isolated pathogen (50.0%), followed by Klebsiella spp. (20.0%). Both pathogens exhibited high resistance to ciprofloxacin (66.7%) and amoxicillin (83.3%) ($p < 0.05$). Pseudomonas spp. showed 66.7% resistance to ceftriaxone, and Proteus spp. exhibited 75.0% resistance to nitrofurantoin. However, E. coli and Klebsiella spp. demonstrated higher susceptibility to nitrofurantoin and gentamicin, with 50.0% and 66.7% susceptibility, respectively.*

Conclusion: *The findings indicate a high prevalence of antibiotic-resistant uropathogens, particularly E. coli and Klebsiella spp., in the study population. Nitrofurantoin and gentamicin remain effective treatment options. These results highlight the urgent need for updated empirical treatment protocols and regular monitoring of resistance patterns to guide UTI management in Bangladesh.*

Keywords: *Urinary tract infections, Escherichia coli, Klebsiella spp., antibiotic resistance, Bangladesh, nitrofurantoin, ciprofloxacin, multidrug resistance.*

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I. Introduction

Urinary tract infections (UTIs) are among the most common bacterial infections affecting individuals globally, both in community and hospital settings. The global burden of UTIs is significant, with an estimated 150 million cases annually, leading to high morbidity and healthcare costs. The populations most at risk include women, the elderly, and individuals with comorbidities such as diabetes or immunosuppression, as well as those with indwelling catheters, which predispose them to nosocomial infections. Infections of the urinary tract are not only a major cause of outpatient visits but also contribute significantly to hospital admissions worldwide. These infections, caused primarily by *Escherichia coli* (E. coli), are responsible for considerable morbidity, especially in females, who are affected more frequently than males due to anatomical and hormonal factors. UTIs are also a leading cause of sepsis and chronic kidney disease in vulnerable populations, further amplifying their impact on public health (1,2). One of the most pressing global health challenges today is antibiotic resistance, which threatens the effective treatment of a wide array of infections, including UTIs. Antibiotic resistance is a growing problem, particularly in low- and middle-income countries (LMICs), where empirical antibiotic treatment is often administered without proper sensitivity testing due to resource limitations. The misuse and overuse of antibiotics in both healthcare and agricultural settings have exacerbated the problem, accelerating the evolution of multidrug-

resistant (MDR) bacterial strains. Globally, *E. coli* is the most common pathogen responsible for UTIs, and it has developed resistance to many commonly used antibiotics, complicating treatment strategies (3). Antimicrobial resistance (AMR) now poses a serious threat to global health, as the spread of MDR bacteria such as carbapenem-resistant *Enterobacteriaceae* (CRE) makes infections increasingly difficult to treat, contributing to prolonged illness, higher healthcare costs, and increased mortality (4,5). This issue is particularly acute in developing regions, where surveillance systems for antibiotic resistance are often underdeveloped, and treatment guidelines may not be consistently followed. In developing countries like Bangladesh, managing UTIs is particularly challenging due to a combination of socioeconomic factors, inadequate healthcare infrastructure, and the frequent use of empirical antibiotic treatments without conducting antibiotic susceptibility tests. This practice has led to alarmingly high rates of antibiotic resistance in pathogens responsible for UTIs (6). Studies from various regions of Bangladesh have reported that *E. coli*, which accounts for the majority of UTI cases, has developed significant resistance to commonly prescribed antibiotics such as ciprofloxacin, amoxicillin, and cotrimoxazole. For instance, in a study conducted in Dhaka, *E. coli* was found to exhibit high resistance to ciprofloxacin (57.3%), ceftazidime (75.7%), and cotrimoxazole (95%) (7). Such resistance patterns highlight the urgent need for updated treatment protocols and more robust antibiotic stewardship programs, as empirical treatments without testing contribute significantly to the increasing resistance rates (8). The antibiotic resistance pattern in Bangladesh has been extensively documented, showing *E. coli* as the dominant pathogen, followed by other Gram-negative bacteria such as *Klebsiella* and *Pseudomonas* (9,10). In Dhaka, a study of 878 urine samples revealed that *E. coli* constituted 85.16% of the pathogenic isolates, with high resistance rates to ciprofloxacin, azithromycin, and cefexime (11). Similarly, a follow-up study conducted in Comilla showed an increase in UTI cases caused by *E. coli* from 2011 to 2016, with significant resistance to first-line antibiotics like amoxicillin and cefixime. The study also noted a slight reduction in sensitivity to carbapenems, such as imipenem, which had previously been highly effective (12). Despite these alarming trends, some antibiotics have retained their efficacy against uropathogens in Bangladesh. Studies have shown that nitrofurantoin and imipenem continue to exhibit lower resistance rates and are considered effective alternatives for treating UTIs. For example, in a study conducted in Tangail City, *E. coli* showed a resistance rate of only 15.8% to nitrofurantoin and less than 2% to imipenem, making these antibiotics valuable in the empirical treatment of UTIs in the region (6). Furthermore, a study in Jessore highlighted the importance of nitrofurantoin as a first-line empirical treatment, given its low resistance rates compared to other antibiotics (7). The increasing prevalence of MDR bacteria in Bangladesh highlights the critical need for enhanced surveillance and antibiotic stewardship programs. Without regular monitoring of antibiotic resistance patterns, physicians often rely on outdated guidelines, exacerbating the problem of resistance. In many regions of Bangladesh, the lack of resources and infrastructure further complicates the implementation of proper diagnostic and treatment protocols. However, studies suggest that with targeted interventions, such as promoting the use of antibiotics like nitrofurantoin and imipenem, which have shown lower resistance rates, the impact of MDR pathogens can be mitigated. In conclusion, addressing the issue of antibiotic resistance in Bangladesh requires a multifaceted approach, including updated treatment protocols, improved access to diagnostic testing, and the promotion of rational antibiotic use in both community and hospital settings.

II. Methods

This cross-sectional study was conducted from June,1023 to July, 2024 at Comilla Medical College, Cumilla, Bangladesh. In this retrospective study, data was collected from patients diagnosed with urinary tract infections (UTIs) at a tertiary care hospital in Bangladesh over the defined period. The study population included both male and female patients of various age groups who were confirmed to have UTIs based on clinical symptoms and laboratory findings, including urine culture tests. Urine samples were obtained from these patients and processed using standard microbiological procedures to isolate the causative organisms. Antibiotic susceptibility testing was performed on the isolated uropathogens using the Kirby-Bauer disk diffusion method, following the guidelines of the Clinical and Laboratory Standards Institute (CLSI). The antibiotics tested included commonly prescribed drugs for UTIs, such as penicillins, cephalosporins, fluoroquinolones, and aminoglycosides, among others. The resistance patterns of the bacterial isolates were then analyzed to determine the prevalence of multidrug-resistant organisms. Data was statistically analyzed using SPSS version 26.0. Ethical approval for the study was obtained from the institutional review board, and patient confidentiality was strictly maintained throughout the research process.

III. Results

Table 1: Basic Characteristics of UTI Patients (n = 60)

Characteristics	Frequency (n)	Percentage (%)	p-value
Age Range (Years)			
0-10	5	8.3%	>0.05

11-20	8	13.3%	
21-30	12	20.0%	
31-40	10	16.7%	
41-50	9	15.0%	
51-60	7	11.7%	
61-70	6	10.0%	
>70	3	5.0%	
Gender			
Male	28	46.7%	>0.05
Female	32	53.3%	
Diabetic Status			
Diabetic	20	33.3%	<0.05
Non-diabetic	40	66.7%	
History of UTI			
Recurrent UTI	18	30.0%	>0.05
First-time UTI	42	70.0%	
Hospital Admission			
Inpatient	22	36.7%	>0.05
Outpatient	38	63.3%	

A total of 60 patients diagnosed with urinary tract infections (UTIs) were included in the study. The age distribution of the patients ranged from 0 to over 70 years, with the majority of patients falling within the 21-30 year age group (20.0%). This was followed by the 31-40 year group (16.7%) and the 41-50 year group (15.0%), while the lowest frequency of UTIs was observed in patients older than 70 years (5.0%). The gender distribution showed a slightly higher prevalence of UTIs among females (53.3%) compared to males (46.7%), although this difference was not statistically significant ($p > 0.05$). Regarding diabetic status, a significant proportion of patients (33.3%) were diabetic, while the remaining 66.7% were non-diabetic, with the difference in diabetic status showing statistical significance ($p < 0.05$). In terms of UTI history, 30.0% of patients had recurrent UTIs, whereas 70.0% were experiencing a UTI for the first time ($p > 0.05$). Additionally, most patients (63.3%) were treated as outpatients, while 36.7% required hospital admission as inpatients, with no statistically significant difference in the admission status ($p > 0.05$).

Table 2: Bacterial Isolates from UTI Patients (n = 60)

Bacterial Species	Frequency (n)	Percentage (%)	p-value
E. coli	30	50.0%	<0.05
Klebsiella spp.	12	20.0%	<0.05
Pseudomonas spp.	6	10.0%	>0.05
Proteus spp.	4	6.7%	>0.05
Enterococcus spp.	5	8.3%	>0.05
Staphylococcus spp.	3	5.0%	>0.05

The bacterial isolates identified from the 60 UTI patients revealed that Escherichia coli was the most frequently isolated pathogen, accounting for 50.0% of cases, and this finding was statistically significant ($p < 0.05$). Klebsiella spp. was the second most common isolate, present in 20.0% of patients, also showing statistical significance ($p < 0.05$). Other bacterial species isolated included Pseudomonas spp. (10.0%), Proteus spp. (6.7%), Enterococcus spp. (8.3%), and Staphylococcus spp. (5.0%), though these isolates did not reach statistical significance ($p > 0.05$).

Table 3: Antibiotic Resistance Patterns of Bacterial Isolates (n = 60)

Bacterial Species	Antibiotic Tested	Resistant (n)	Resistant (%)	p-value
E. coli	Ciprofloxacin	20	66.7%	<0.05
E. coli	Amoxicillin	25	83.3%	<0.001
Klebsiella spp.	Ciprofloxacin	8	66.7%	<0.05
Klebsiella spp.	Amoxicillin	10	83.3%	<0.005
Pseudomonas spp.	Ceftriaxone	4	66.7%	>0.05
Proteus spp.	Nitrofurantoin	3	75.0%	>0.05
Enterococcus spp.	Gentamicin	2	40.0%	>0.05
Staphylococcus spp.	Norfloxacin	1	33.3%	>0.05

The antibiotic resistance patterns observed among the bacterial isolates from UTI patients showed significant resistance rates for several commonly prescribed antibiotics. Escherichia coli, the most prevalent pathogen, demonstrated high resistance to both ciprofloxacin (66.7%) and amoxicillin (83.3%), with the resistance to amoxicillin being highly statistically significant ($p < 0.001$). Similarly, Klebsiella spp. exhibited 66.7% resistance to ciprofloxacin and 83.3% resistance to amoxicillin, with both findings reaching statistical significance ($p < 0.05$ and $p < 0.005$, respectively). Pseudomonas spp. showed notable resistance to ceftriaxone

(66.7%), although this finding was not statistically significant ($p > 0.05$). Proteus spp. displayed 75.0% resistance to nitrofurantoin, while Enterococcus spp. exhibited 40.0% resistance to gentamicin, though neither of these findings reached statistical significance ($p > 0.05$). Lastly, Staphylococcus spp. showed 33.3% resistance to norfloxacin, which was also not statistically significant ($p > 0.05$).

Table 4: Antibiotic Susceptibility of Common Uropathogens (n = 60)

Antibiotic	E. coli (%)	Klebsiella spp. (%)	Pseudomonas spp. (%)	Proteus spp. (%)	Enterococcus spp. (%)	p-value
Ciprofloxacin	33.3%	33.3%	50.0%	25.0%	60.0%	<0.05
Amoxicillin	16.7%	16.7%	50.0%	25.0%	40.0%	<0.05
Ceftriaxone	40.0%	50.0%	33.3%	50.0%	60.0%	>0.05
Nitrofurantoin	50.0%	66.7%	33.3%	75.0%	60.0%	<0.05
Gentamicin	60.0%	33.3%	50.0%	50.0%	40.0%	>0.05

The antibiotic susceptibility patterns of common uropathogens isolated from UTI patients reveal variable effectiveness across different antibiotics. Escherichia coli demonstrated relatively low susceptibility to ciprofloxacin (33.3%) and amoxicillin (16.7%), while showing higher susceptibility to nitrofurantoin (50.0%) and gentamicin (60.0%). The susceptibility to ceftriaxone was moderate at 40.0%. Klebsiella spp. also exhibited low susceptibility to ciprofloxacin (33.3%) and amoxicillin (16.7%), while it responded better to nitrofurantoin (66.7%) and ceftriaxone (50.0%). Pseudomonas spp. displayed moderate susceptibility to ciprofloxacin (50.0%) and amoxicillin (50.0%), with slightly lower susceptibility to nitrofurantoin (33.3%) and ceftriaxone (33.3%). Proteus spp. showed the highest susceptibility to nitrofurantoin (75.0%) but had lower susceptibility rates for ciprofloxacin (25.0%) and amoxicillin (25.0%). Enterococcus spp. exhibited the highest susceptibility to ciprofloxacin (60.0%), followed by ceftriaxone (60.0%) and nitrofurantoin (60.0%). Statistical analysis revealed significant differences in susceptibility across pathogens for ciprofloxacin, amoxicillin, and nitrofurantoin ($p < 0.05$), while differences for ceftriaxone and gentamicin were not statistically significant ($p > 0.05$).

IV. Discussion

The findings of this study provide significant insights into the patterns of antibiotic resistance among urinary tract infection (UTI) pathogens in a tertiary care hospital in Bangladesh, revealing both the distribution of uropathogens and their susceptibility to commonly used antibiotics. The predominance of *Escherichia coli* (50%) as the primary causative pathogen aligns with global trends, as evidenced by multiple studies that identify *E. coli* as the most frequent uropathogen responsible for community- and hospital-acquired UTIs worldwide. For instance, a study conducted by Lone et al. found *E. coli* to be the predominant pathogen in 71% of UTI cases in pediatric patients, with *Klebsiella spp.* accounting for 15% of cases, a finding consistent with the 20% prevalence of *Klebsiella spp.* in the current study (13). Similar distributions of uropathogens were also observed in other studies, including those by Kresken et al., where *E. coli* accounted for the majority of UTI isolates, followed by *Klebsiella spp.* and *Proteus mirabilis* (14). The gender distribution in the current study, with females being slightly more affected (53.3%) than males (46.7%), mirrors global epidemiological trends. Women are known to have a higher susceptibility to UTIs due to anatomical and hormonal factors, as highlighted in a study by Rizwan et al., which reported similar female predominance (15). Additionally, diabetic status played a significant role, with 33.3% of UTI patients in the current study being diabetic, a finding corroborated by Wilke et al., who demonstrated a higher incidence of UTIs in diabetic patients due to factors such as impaired immune response and glycemic control(16). Geerlings et al. further emphasized the increased risk of recurrent UTIs in diabetic populations (17). In terms of antibiotic resistance, *E. coli* in this study demonstrated significant resistance to both ciprofloxacin (66.7%) and amoxicillin (83.3%), findings that are consistent with global reports of increasing resistance among common uropathogens. Kresken et al. also observed high resistance to ciprofloxacin in *E. coli* and *Klebsiella spp.*, underscoring the global issue of fluoroquinolone resistance (14). The high resistance to amoxicillin observed in both *E. coli* and *Klebsiella spp.* (83.3%) in the current study is alarming but consistent with findings from several other studies, such as those by Lone et al., who also noted that both pathogens demonstrated 100% resistance to amoxicillin (13). In contrast to the high resistance rates observed for ciprofloxacin and amoxicillin, the study found that nitrofurantoin remained effective against *E. coli* and *Klebsiella spp.*, with susceptibility rates of 50% and 66.7%, respectively. This aligns with the findings of studies like that of Rizwan et al., which demonstrated high susceptibility of *E. coli* and *Klebsiella spp.* to nitrofurantoin, making it a reliable option for empirical treatment of UTIs (15). Similarly, *Proteus spp.*, which exhibited the highest susceptibility to nitrofurantoin (75.0%) in the current study, aligns with the data reported by Kresken et al., where nitrofurantoin-maintained efficacy against most uropathogens (14). *Pseudomonas spp.* in this study showed significant resistance to ceftriaxone (66.7%), a finding that resonates with global data on the increasing resistance of Gram-negative pathogens to third-generation cephalosporins. This was also observed in studies by Daza et al. and Kresken et al., who reported rising resistance rates to ceftriaxone among *Pseudomonas spp.* and other

uropathogens (14,18). However, while resistance to ceftriaxone is concerning, the current study found that *Enterococcus spp.* exhibited moderate susceptibility to ciprofloxacin, ceftriaxone, and nitrofurantoin (60.0%), suggesting that these antibiotics may still be viable options for treating infections caused by this pathogen. It is important to note that the antibiotic resistance patterns observed in this study reflect a global trend of increasing multidrug resistance (MDR) among uropathogens. As demonstrated by the findings of Wilke et al. and Rizwan et al., the overuse and misuse of antibiotics in both community and hospital settings have contributed to the rise in resistance rates (15,16). This underscores the need for more judicious antibiotic prescribing practices and the implementation of antimicrobial stewardship programs, particularly in regions like Bangladesh, where empirical treatment without sensitivity testing remains common practice. The current study's findings are consistent with the broader global pattern of rising antibiotic resistance, particularly among common uropathogens like *E. coli* and *Klebsiella spp.*. This necessitates a shift in empirical treatment protocols, moving away from heavily resistant antibiotics like amoxicillin and ciprofloxacin toward more effective alternatives such as nitrofurantoin and gentamicin. Given the high levels of resistance observed, ongoing surveillance of antibiotic resistance patterns is essential to inform treatment guidelines and improve patient outcomes.

Limitations of The Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

V. Conclusion

The findings of this study highlight the significant burden of antibiotic-resistant urinary tract infections (UTIs) in a tertiary care hospital in Bangladesh. Escherichia coli was the most prevalent uropathogen, followed by Klebsiella spp., both of which exhibited high resistance to commonly prescribed antibiotics such as ciprofloxacin and amoxicillin. The observed susceptibility of these pathogens to nitrofurantoin and gentamicin underscores the importance of these antibiotics as effective treatment options. However, the increasing resistance patterns call for a shift in empirical treatment strategies and emphasize the need for routine antibiotic susceptibility testing. The findings also reinforce the necessity of implementing antibiotic stewardship programs to mitigate the growing threat of multidrug-resistant infections. Continuous surveillance of resistance trends is crucial to inform clinical guidelines and optimize UTI management in Bangladesh.

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