



## Study of Antimicrobial Sensitivity Pattern of Bacterial Pathogens Causing Urinary Tract Infections at a Tertiary Care Hospital

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### ABSTRACT

Urinary tract infection (UTI) is one of the most common bacterial infection in outpatients and hospitalised patients in Bangladesh. This cross-sectional study was carried out in Jalalabad Ragib-Rabeya Medical College Hospital, Sylhet, during the period of October 2023 to April 2024. The aim of the study was to determine the antibiotic sensitivity pattern among uropathogens causing UTI. Clinically diagnosed cases of UTI from the outpatient department and inpatient department were selected for the study purpose. Urine was collected from symptomatic UTI cases attending the hospital and processed in the microbiology lab. A total of 3050 urine samples were analysed. Among the total number, 400 urine samples were culture positive. The most common organisms isolated were *Escherichia coli* (68.8%), *Klebsiella* (30.2%) and *Pseudomonas* (1%). More than 90% of the isolates were sensitive to nitrofurantoin, while more than 80% were sensitive to meropenem, netilmicin and piperacillin-tazobactam. Very high rates of resistance were seen against cefixime (78%), azithromycin (77.8%), cefepime (74.8%) and cefuroxime (74.8%). *Escherichia coli* showed high sensitivity to nitrofurantoin (94.2%) and meropenem (89.8%) with good sensitivity to fosfomycin (86.2%), piperacillin-tazobactam (84.7%), netilmicin (84%) and amikacin (80%). *Klebsiella* was highly sensitive to nitrofurantoin (89.2%), meropenem (86.8%), fosfomycin (83.5%), netilmicin (83.5%), piperacillin-tazobactam (82.6%) and amikacin (75.2%). *Pseudomonas* was 100% sensitive to nitrofurantoin, meropenem, netilmicin, amikacin and piperacillin-tazobactam. Females of reproductive age groups are vulnerable to developing UTIs. *E. coli* and *Klebsiella* are two common pathogens causing UTIs. Nitrofurantoin and meropenem are highly sensitive, and cephalosporins and azithromycin are highly resistant to these organisms.

**Keywords:** Antimicrobial, Sensitive, Resistant, Urinary tract infections, *Escherichia coli*.

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### INTRODUCTION

Urinary tract infections (UTIs) are the second most common infections after respiratory tract infections among human beings, which may affect the urethra, bladder, or kidneys<sup>1</sup>. The vast majority of uncomplicated UTIs are caused by the gram-negative bacillus *Escherichia coli*,

with other pathogens including *Enterococci*, *Staphylococcus saprophyticus*, *Klebsiella spp.* and *Proteus mirabilis*<sup>2</sup>. Many different microorganisms can cause UTIs, though the most common pathogens in the community are *Escherichia coli* and other *Enterobacteriaceae*, which account for approximately 75% of the isolates<sup>3</sup>. However, UTI is a common scenario in our daily clinical practice, but the increasing antimicrobial resistance is associated with treatment failure and overburdening of healthcare costs around the globe<sup>4</sup>. The prevalence and pattern of antimicrobial resistance and susceptibility of uropathogens

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are determined by a variety of factors and are constantly changing. In this context, continuous monitoring of the susceptibility pattern is extremely important for the choice of treatment modality<sup>5</sup>.

Antibiotics have been a cornerstone in treating infectious diseases, thereby improving patients' quality of life and life expectancy<sup>6</sup>. In women, bacterial cystitis is the most common bacterial infection. Every woman has a 60% lifetime risk of developing bacterial cystitis, which develops mostly before the age of 24. By contrast, men have a lifetime risk of only 13%<sup>7</sup>. UTI is said to exist when pathogenic organisms are detected in the urine, urethra, bladder, kidney or prostate. In most instances, growth of more than  $10^5$  organisms per millilitre from a properly collected midstream clean-catch urine sample indicates infection. However, significant bacteriuria is lacking in some cases of true UTI. Especially in symptomatic patients, a smaller number of bacteria ( $10^2$  to  $10^4$ /ml) may signify infection. In urine specimens obtained by suprapubic aspiration or in-and-out catheterisation and in samples from a patient with an indwelling catheter, colony counts of  $10^2$  to  $10^4$ /ml generally indicate infection. Conversely, colony counts  $>10^5$ /ml of midstream urine are occasionally due to specimen contamination, which is especially likely when multiple species are found<sup>8</sup>. The majority of patients present with symptoms of UTI, including urinary frequency, urinary urgency, burning on micturition, blood in the urine, strangury, suprapubic pain, or a change of urine colour or scent<sup>9</sup>. Several predisposing factors might contribute to the higher prevalence of UTIs among women<sup>10</sup>. It has been reported that adult women have a higher prevalence of UTIs than men, principally due to anatomical and physical factors<sup>11</sup>.

The emergence of antibiotic resistance in the management of UTI is a serious public health issue, particularly in the developing world, where apart from a high level of poverty, ignorance and poor hygienic practices, there is also a high prevalence of fake and spurious drugs of questionable quality in circulation. In patients with suspected UTI, antibiotic treatment is usually started empirically, before urine culture results are available. To ensure appropriate treatment, knowledge of the organisms that cause UTI and their antibiotic susceptibility is mandatory<sup>12</sup>. Antibiotic resistance emerges commonly when patients are treated with empiric antimicrobial drugs. To overcome these difficulties and to improve the outcome of serious infections, monitoring of resistance patterns in the hospital is needed<sup>13</sup>. As antimicrobial resistance to organisms is increasing all over the world, even in the developed countries, the present study analysed the antimicrobial sensitivity pattern of pathogens isolated from the urine samples of patients suffering from UTI.

## MATERIALS AND METHODS

This cross-sectional study was conducted in the department of microbiology from October 2023 to April 2024 in Jalalabad Ragib-Rabeya Medical College Hospital, Sylhet. Clinically diagnosed cases of UTI from the outpatient department and inpatient department were selected for the purpose of the study. The study was carried out on a total of 3050 samples, in which 400 cases were culture positive. The study excluded patients that have mixed growth and no microbial findings. Patients were included in this study by the consecutive method of sampling. Clean-catch midstream urine specimens from patients diagnosed clinically to be having UTI on the basis of symptoms (fever, dysuria and increased frequency of urination) were inoculated on Blood Agar and McConkey Agar plates, which were incubated aerobically at 37°C overnight. Plates showing growth suggestive of significant bacteriuria, with colony counts exceeding  $10^5$ cfu/ml were subjected to standard biochemical tests for identification and antimicrobial sensitivity testing by Kirby-Bauer disc diffusion method using Muller-Hinton agar plates. Interpretation as 'sensitive' or 'resistant' was done on the basis of the diameters of zones of inhibition of bacterial growth as recommended by the disc manufacturer. Data were analysed manually and presented as frequency and percentage. The antibiotics used for susceptibility testing were amikacin, azithromycin, co-trimoxazole, ceftriaxone, ciprofloxacin, cefuroxime, cefepime, cefixime, fosfomycin, gentamicin, meropenem, levofloxacin, nitrofurantoin, netilmicin, piperacillin-tazobactam.

## RESULTS

In this study, a total of 400 urine culture positive samples were analysed. Out of 400 patients, 333 (83.25%) were female and 67 (16.75%) were male (table-I).

The highest prevalence of UTI was found in females between the age group of 18-40 years (61.6%) (table-II).

The most common organism isolated was *Escherichia coli* (68.8%), followed by *Klebsiella* (30.2%) and *Pseudomonas* (1%) (table-III).

More than 90% of the organisms were sensitive to nitrofurantoin, while more than 80% were sensitive to meropenem, netilmicin and piperacillin-tazobactam (table-IV).

*Escherichia coli* was highly sensitive to nitrofurantoin (94.2%), meropenem (89.8%) with good sensitivity to fosfomycin (86.2%), piperacillin-tazobactam (84.7%), netilmicin (84%) and amikacin (80%). It was found that *Klebsiella* was highly sensitive to nitrofurantoin (89.2%) and meropenem (86.8%), while it was sensitive to fosfomycin (83.5%), netilmicin (83.5%), piperacillin-tazobactam (82.6%) and amikacin (75.2%). *Pseudomonas* was 100% sensitive to nitrofurantoin,

**Table-I:** Sex distribution of culture positive cases among study population, (n=400).

Gender	Frequency	Percentage
Female	333	83.3
Male	67	16.7
Total	400	100

**Table-II:** Distribution of cases of UTI causing in different age and sex, (n=400).

Age group (years)	Females n (%)	Males n (%)
18-40	205 (61.6)	16 (23.9)
41-60	60 (18.0)	16 (23.9)
61-80	68 (20.4)	35 (52.2)

**Table-III:** Isolation of different organisms among culture positive cases, (n=400).

Bacterial pathogens	Frequency	Percentage
<i>Escherichia coli</i>	275	68.8
<i>Klebsiella spp.</i>	121	30.2
<i>Pseudomonas spp</i>	4	1
Total	400	100

**Table-IV:** Overall percentage of uropathogens sensitivity to antibiotics.

Antibiotics	Sensitivity n (%)	Resistance n (%)
Amikacin	315 (78.8)	85 (21.2)
Azithromycin	89 (22.2)	311 (77.8)
Co-trimoxazole	229 (57.2)	171 (42.8)
Ceftriaxone	133 (33.2)	267 (66.8)
Ciprofloxacin	113 (28.2)	287 (71.8)
Cefuroxime	101 (25.3)	299 (74.8)
Cefepime	101 (25.2)	299 (74.8)
Cefixime	88 (22)	312 (78)
Fosfomycin	264 (66)	136 (34)
Gentamicin	286 (71.5)	114 (28.5)
Meropenem	356 (89)	44 (11)
Levofloxacin	234 (58.5)	166 (41.5)
Nitrofurantoin	371 (92.8)	29 (7.2)
Netilmicin	336 (84)	64 (16)
Piperacillin tazobactam	337 (84.2)	63(15.8)

**Table-V:** Antimicrobial sensitivity pattern of *Escherichia coli*, *Klebsiella* and *Pseudomonas*.

Antibiotics	<i>Escherichia Coli</i>		<i>Klebsiella</i>		<i>Pseudomonas</i>	
	Sensitivity n (%)	Resistance n (%)	Sensitivity n (%)	Resistance n (%)	Sensitivity n (%)	Resistance n (%)
Amikacin	220 (80)	55 (20)	91 (75.2)	30 (24.8)	4 (100)	0
Azithromycin	58 (21.1)	217 (78.9)	30 (24.8)	91 (75.2)	1 (25)	3 (75)
Co-trimoxazole	161 (58.5)	114 (41.5)	65 (53.7)	56 (46.3)	3 (75)	1 (25)
Ceftriaxone	88 (32)	187 (68)	41 (33.9)	80 (66.1)	2 (50)	2 (50)
Ciprofloxacin	77 (28)	198 (72)	36 (29.7)	85 (70.3)	0	4 (100)
Cefuroxime	70 (25.5)	205 (74.5)	31 (25.6)	90 (74.4)	0	4 (100)
Cefepime	53 (19.3)	222 (80.7)	35 (28.9)	86 (71.1)	0	4 (100)
Cefixime	58 (21.1)	217 (78.9)	23 (19 )	98 (81)	0	4 (100)
Fosfomycin	237 (86.2)	38 (13.8)	101 (83.5)	20 (16.5)	4 (100)	0
Gentamicin	198 (72)	77 (28)	84 (69.4)	37 (30.6)	3 (75)	1 (25)
Meropenem	247 (89.8)	28 (10.2)	105 (86.8)	16 (13.2)	4 (100)	0
Levofloxacin	160 (58.2)	115 (41.8)	71 (58.7)	50 (41.3)	2 (50)	2 (50)
Nitrofurantoin	259 (94.2)	16 (5.8)	108 (89.2)	13 (10.8)	4 (100)	0
Netilmicin	231 (84)	44 (16)	101 (83.5)	20 (16.5)	4 (100)	0
Piperacillin Tazobactam	233 (84.7)	42 (15.3)	100 (82.6)	21 (17.4)	4 (100)	0

meropenem, amikacin, netilmicin and piperacillin-tazobactam (table-V).

## DISCUSSION

UTI is more common in the females than in the males with a ratio of 8:1. Around 50-60% of women will experience an episode of UTI in their lifetime<sup>14</sup>. Our study showed a higher frequency of urinary tract infection among females (83.3%) than males (16.7%). Mounir et al. also found that the prevalence of infection is more common in females (67.6%) than male (32.4%)<sup>15</sup>.

The study observed that *E. coli* was the main leading uropathogen responsible for UTI. The other common pathogen were *Klebsiella* and *Pseudomonas*. This is consistent with the findings of Nicolle LE, who found that *E. coli* was the most frequently reported isolate from patients with UTIs<sup>16</sup>. The reason of the highest rate of *E. coli* is that they are normal faecal flora and uropathogen strains of *E. coli* that have an adherence factor called P fimbriae or pili, which mediate the attachment of *E. coli* to uroepithelial cells<sup>17</sup>.

The antimicrobial resistance pattern varies from place to place and from time to time. In this study, *E. coli* was found to be most sensitive to nitrofurantoin (94.2%), meropenem (89.8%), fosfomycin (86.2%), piperacillin tazobactam (84.7%), netilmicin (84%), amikacin (80%). A recent study in India showed that nitrofurantoin had the best in vitro susceptibility profile against *E. coli*<sup>18</sup>.

This study revealed 72% of *E. coli* resistance to ciprofloxacin. This resistance rate is higher than the other studies conducted in Bangladesh<sup>19,20</sup>. Ciprofloxacin resistance rate (79.66%) to *E. coli* is higher in one study in Saudi Arabia<sup>21</sup>. A multicentre study of 13 countries in the Asia-Pacific region from 2010-2013 reported lower susceptibility to ciprofloxacin<sup>22</sup>.

Azithromycin was also used to eliminate UTIs. But it shows 78.9% resistance to *E. coli* in this study. A study from West Bengal, India, reported azithromycin resistance to *E. coli* of about 30%<sup>23</sup>.

The present study showed *E. coli* was highly resistant to cefepime (80.7%), cefixime (78.9%), azithromycin (78.9%), cefuroxime (74.5%), and ceftriaxone (64%). A recent study reported that cefuroxime and ceftriaxone showed higher resistance to urinary *E. coli* (72.41%, and 66.58%, respectively)<sup>24</sup>. Kulkarni et al. also reported that the isolates showed a high level of resistance to ampicillin, cefuroxime, amoxicillin-clavulanic acid, ceftriaxone, ciprofloxacin and cefepime<sup>24</sup>.

We have found that nitrofurantoin was 5.8% and meropenem 10.2% resistant to *E. coli* and accounted for the lowest resistance to antibiotics. Another study in Bangladesh has shown meropenem resistance rate to *E.*

*coli* was 10.5%<sup>25</sup>. So, nitrofurantoin and meropenem were highly effective antibiotics against *E. coli* positive UTI patients. In this study *Klebsiella* showed highly sensitive to nitrofurantoin (89.2%), meropenem (86.8%), while it was also sensitive to fosfomycin (83.5%), nitilmicin 83.5%, piperacillin-tazobactam 82.6% and amikacin 75.2%.

*Klebsiella* was resistant to most of the antibiotics, including cefixime (81%), azithromycin (75.2%), cefuroxime (74.4%), cefepime (71.1%) and ceftriaxone (66.1%). Antibiotic misuse due to availability and practicing an incomplete antibiotic course due to poverty raised multidrug resistance.

## CONCLUSION

From the study, we can conclude that females of reproductive age groups have a higher possibility of developing urinary tract infections. *E. coli* and *Klebsiella* are two common pathogens causing UTIs in our study. Nitrofurantoin and meropenem are highly effective against these organisms. On other hand, most isolated organisms were highly resistant to cefepime, cefixime, azitromycin, cefuroxime, and ceftriaxone. The spread of resistance can be reduced by careful use of antimicrobial agents and increasing awareness among the population about the consequences of resistance. So, we recommend appropriate antimicrobial use in the treatment of UTI patients.

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