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Original article

Bacteriological profile and antibiotic susceptibility pattern of uropathogens in patients with Urinary Tract Infection in a diagnostic center in Narayanganj, Bangladesh

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Abstract:

Background: Urinary tract infections are one of the most common bacterial infections and a leading cause for antibiotic prescriptions in the community. The incidence of urinary tract infections caused by multidrug-resistant uropathogens has been increasing at an alarming rate worldwide, especially in developing countries. ***Objectives:*** The study was done to investigate the causative agents of urinary tract infection and recent antibiotic sensitivity pattern in uropathogens in Narayanganj. ***Methodology:*** A cross-sectional descriptive type of study was conducted in S. Alom Digital Diagnostic Centre, Narayanganj. 281 reports of urine culture and sensitivity test, were collected from laboratory and evaluated retrospectively from July 2025 to December 2025. ***Results:*** Among 281 urine culture reports, 137 (48.75%) cases were culture positive for uropathogens. Females 103 (69.60%) were more affected than males 34 (25.56%). Gram-positive organisms accounted for 6.57% of the isolates [Staphylococcus aureus (3.6%) and Enterococci (2.9%)], while Gram-negative organisms made up 93.43% [Escherichia coli (78.8%), Klebsiella (12.4%) and Pseudomonas (2.2%)]. Antibiotic susceptibility testing revealed excellent susceptibility to Imipenem (100% S), Meropenem (100% S), Amikacin (100% S), Tigecycline (98.21% S), Colistin (95.74% S), Cefepime (87.5% S), Nitrofurantoin (82.81% S) and Cefotaxime (80.37% S) but, high resistance to Tetracycline (100% R), Cephradine (98.44% R), Cotrimoxazole (92.8% R), Amoxyclav (87.70% R), Doxycycline (85.85% R), Ampicillin (83.33% R) & Cefuroxime (80.83% R). Among Gram-positive organisms, high resistance to Penicillin, Cefoperazone, Cephradine, Azithromycin, and Clindamycin was observed while, high susceptibility to Linezolid, Nitrofurantoin, Amikacin, Meropenem, Imipenem, and Amoxiclav was observed. ***Conclusion:*** This study reveals the increasing antibiotic resistance to both Gram-positive and Gram-negative uropathogens. As the antibiotic susceptibility of uropathogens is frequently changing, continuous regional surveillance of resistance patterns is necessary.

Keywords: UTI, Uropathogen, Antibiotic, Susceptibility, Resistance.

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Introduction:

Urinary tract infection (UTI) is defined as the invasion of pathogens into urinary tract tissues extending from the renal cortex to the urethra (urethritis), which includes the prostate (prostatitis), urinary bladder (cystitis), and kidney (pyelonephritis).[1] UTIs are the second most prevalent bacterial infection among people of all ages globally.[2] It is estimated that there are approximately 150 million urinary tract infections per year globally.[3] UTIs are a major reason for antibiotic prescriptions in the community particularly in developing countries.[4]

The prevalence of UTI differs due to age, sex, ethnicity, temperature, and circumcision status.[5] Every woman has a lifetime risk of acquiring UTI of 53%, whilst men have a lifetime risk of 14%.[6] By the age of 24, roughly one-third of women will have experienced a UTI that required antibiotics. Approximately 50% of women will have at least one episode of a UTI during their lives, and nearly 20% to 40% will have reoccurring infections.[7]

For proper diagnosis of UTI, clinical signs, symptoms, urinalysis and urine culture play a vital role. UTI is diagnosed by the gold standard urine culture when more than 10^5 CFU/mL of the same species of bacteria are isolated from two consecutive properly collected specimens of midstream urine in women or from a single specimen with one bacterial species in men.[8] Acute bacteriuria, perinephric abscess with sepsis, or even death are all possible outcomes of the condition.[9] There are two types of UTIs: complicated (cUTIs) and uncomplicated (uUTIs). Certain subpopulations are more susceptible to UTIs than others, including infants, women (more so than men), the elderly, people with spinal cord injuries or catheters, people with diabetes or multiple sclerosis, people with AIDS/HIV, and people with underlying urologic abnormalities.[10]

Gram-negative bacteria such as Escherichia coli, Klebsiella pneumoniae, pseudomonas aeruginosa, Citrobacter species, Enterobacter species, and Proteus species are the most common pathogens involved in UTIs in both community and hospital settings. UTIs are typically caused by gram-positive bacteria such as Staphylococcus aureus, Staphylococcus saprophyticus, and Enterococcus species.1 E. coli is the most common cause of community-acquired UTIs.[11] Some studies suggest that anaerobic cocci cause UTIs in >7% of cases.[12] Although bacteria are responsible for more than 95% of UTIs, other microorganisms such as fungus, parasites, and viruses can also cause them.[13]

Since bacteria are the primary cause of UTIs, using broad spectrum antibiotics is the recommended course of treatment. Widespread use of antibiotics is making the treatment challenging as it accelerates the emergence of drug resistant bacteria. It is more common in lower and middle income countries like Bangladesh, where empirical therapy is a routine practice as the laboratory facility for urine culture is not available everywhere.[14] It's interesting to note that uropathogens can occasionally and locally alter their physiological characteristics in order to cause multi-drug resistance (MDR).[15] MDR uropathogens have become more common in recent years, which is a global public health concern.[14] These infections have been found in both hospitalized and community individuals.[16]

Antimicrobial resistance (AMR) occurs when organisms become resistant to previously effective antimicrobial agents.[17] AMR may be developed by random mutations in DNA of the chromosomes, or via transferring and obtaining new genetic materials between bacteria (by plasmids or transposons) from the same or different genera.[18] Gram-negative bacteria can get resistant genes, located on transferable plasmids, that code for extended-spectrum β-lactamases (ESBLs).[19] Limitation of drug absorption, alteration of a drug target, and active pumping out of a drug are additional significant resistance mechanisms of resistance.[20]

The pattern of antibiotic susceptibility among bacteria differs over time, between hospitals and between geographical areas.[21] The Infectious Disease Society of America recommends that regional surveillance should be conducted in a particular area to monitor variations in antibiotic sensitivity patterns.[22] Prior to lab findings from urine culture, physicians need to consider local sensitivity patterns of uropathogens when deciding empirical therapy.[23]

Continuous monitoring of infection etiology and antibiotic resistance patterns is necessary not just for selecting effective antibiotics for empirical therapy, but also for decreasing antibiotic overuse and misuse.[24] We carried out a retrospective record-based cross-sectional study in Narayanganj district, Bangladesh to investigate the prevalence, etiologies of UTI along with antibiotic susceptibility patterns in Uropathogens according to the World Health Organization (WHO) AWaRe classification which may help the clinicians to choose the best empirical treatment.

Materials and Methods

This retrospective cross-sectional descriptive study was conducted in the Department of Pharmacology, Dhaka Medical College, Dhaka, in collaboration with S. Alom Digital Diagnostic Centre, Narayanganj, over a duration of six months from July 2025 to December 2025. A total of 281 urine reports, either positive or negative for culture and sensitivity tests, recorded at S. Alom Digital Diagnostic Centre were included using purposive sampling. The study population comprised patients aged one year and above of either sex, while patients younger than one year were excluded. Data were collected from laboratory records of the diagnostic centre for the specified study period. There was no associated physical or psychological risk to the samples or participants. Ethical approval for the study was obtained from S. Alom Digital Diagnostic Centre, Narayanganj, and informed consent was not taken as the study was conducted retrospectively.

Chemicals and media

HiChrome UTI agar, blood agar and MacConkey agar were used for the selective isolation and identification of microorganisms causing urinary tract infections and Mueller-Hinton Agar (MHA) was used for antibiotic susceptibility test of the selected urinary cultures. Culture was done aerobically at 37^{o}C for 24 hours.

Sample collection

Clinically suspicious UTI patients provided clean catch midstream urine (MSU) samples of approximately 4-5 ml in sterilized, broad mouthed, universal disposable containers, according to the Clinical and Laboratory Standards Institute (CLSI), 2020 guidelines.[25] They were instructed how to collect the correct sample in a clean container aseptically right before collection.

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility test was done by the Kirby-Bauer agar disk diffusion system.[26] Diameters of the zone of inhibition were measured to the nearest millimeter and classified as sensitive or resistant to each antibiotic according to CLSI, 2020 guidelines.[25] Patient "Block samples" (clinical stocks) were used for Antimicrobial Susceptibility Testing quality control. Antibiotics tested for both gram positive and gram negative uropathogens are shown in Table III and Table II respectively.

Data collection, recording, and analysis: Data were collected from laboratory record of S. Alom Digital Diagnostic Centre, Narayanganj. The information was recorded and analyzed. All data were entered, checked, and scrutinized for the following standard procedure and analyzed by using Microsoft Office Excel 2024. Quantitative data were summarized by number and percentages. Appropriate analysis was done to fulfill the objectives of the study. Data was presented by tables and graphs based on the nature of data.

Results

A total of 281 urine culture reports were collected from the laboratory during the study period. Overall, 137 samples (48.75%) tested positive for microbial growth while, 144 samples (51.25%) were culture negative. The rate of growth positive isolates among females was 69.60% (103/148) while, in males it was 25.56% (34/133). Also, the rate of growth positive isolates in the adults was 67.88% (93/137), in the children 16.79% (23/137) and in the elderly 15.33% (21/137), which is shown in Table I.

Table I: Rate of isolation of uropathogens from urine samples (N=281)

Variables			Percentage
1.Based on Culture and Sensitivity result	**Culture positive**		**48.75% (137/281)[a]**
	Based on Gram reaction	Gram positive	6.57% (9/137)[c]
		Gram negative	93.43% (128/137)[c]
	Based on age	Children (1-18Y)	16.79% (23/137)[c]
		Adult (19-59Y)	67.88% (93/137)[c]
		Elderly (≥60Y)	15.33% (21/137)[c]
	Culture negative		**51.25% (144/281)[a]**
2. Based on sex	**Male**		25.56% (34/133)[b]
	Female		69.60% (103/148)[b]

[a]Rate of isolation was determined by total number of positive cases divided by total number of cases (positive+negative).
[b]Rate of isolation was determined by number of same sex positive cases divided by total number of same sex cases (positive+negative).
[c]Rate of isolation was determined by number of positive cases divided by total number of positive cases.

The results of the urine cultures taken from patients revealed that Gram negative bacteria isolated were 93.43% (128/137) and Gram positive bacteria were 6.57% (9/137) as shown in Table I. Among Gram negative organisms, Escherichia coli was isolated **78.83% (108/137),** followed by Klebsiella **12.41% (17/137)** and Pseudomonas **2.19% (3/137).** Among Gram positive organisms, Staphylococcus aureus was **3.65% (5/137),** and Enterococcus was **2.92% (4/137)** as shown in Figure 1.

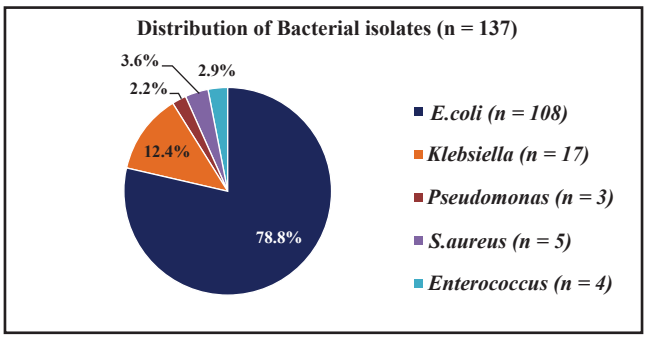

Figure 1: Distribution of various organisms isolated from urine cultures (n=137)

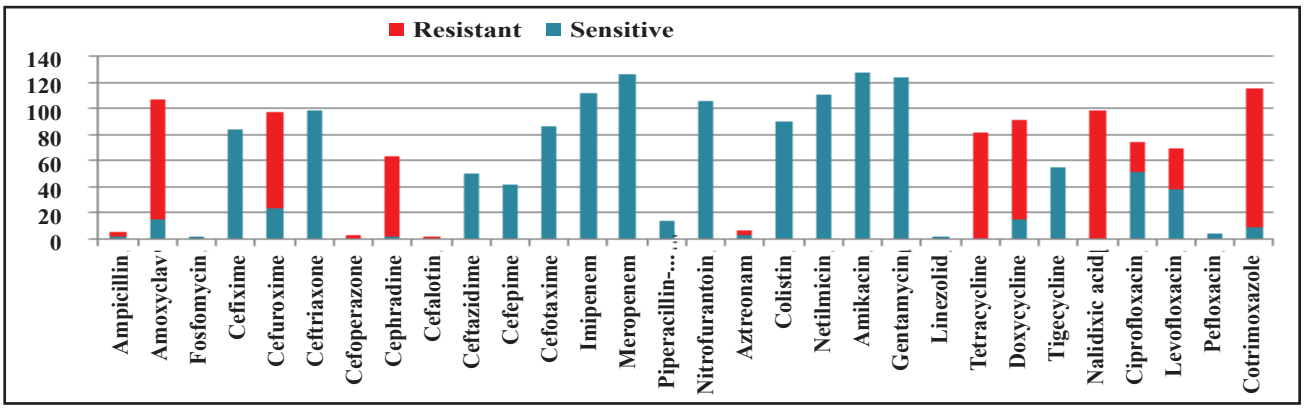

Figure 2: Antibiotic sensitivity and resistance profiles of isolated gram-negative uropathogens (n=128)

Table II: Antibiotic sensitivity and resistance pattern of isolated gram-negative uropathogens (n=128)

	Sensitive (S) n (%)	Resistant (R) n (%)	Total N
WHO Access Group antibiotics			
Ampicillin	01 (16.67%)	05 (83.33%)	06
Amoxyclav	15 (12.30%)	107 (87.70%)	122
Cephradine	01 (1.56%)	63 (98.44%)	64
Cefalotin	00	01 (100%)	01
Nitrofurantoin	106 (82.81%)	22 (17.19%)	128
Amikacin	128 (100%)	00	128
Gentamicin	124 (97.64%)	3 (2.36%)	127
Tetracycline	00	82 (100%)	82
Doxycycline	15 (14.15%)	91 (85.85%)	106
Cotrimoxazole	09 (7.2%)	116 (92.8%)	125
WHO Watch Group antibiotics			
Fosfomycin	01 (100%)	00	01
Cefixime	84 (65.62%)	44 (34.38%)	128
Cefuroxime	23 (19.17%)	97 (80.83%)	120
Ceftriaxone	99 (77.34%)	29 (22.66%)	128
Cefoperazone	00	03 (100%)	03
Ceftazidime	50 (67.57%)	24 (32.43%)	74
Cefepime	42 (87.5%)	06 (12.5%)	48
Cefotaxime	86 (80.37%)	21(19.63%)	107
Imipenem	112 (100%)	00	112
Meropenem	127 (100%)	00	127
Piperacillin-tazobactam	14 (73.68%)	05 (26.32%)	19
Netilmicin	111 (100%)	00	111
Ciprofloxacin	51 (40.8%)	74 (59.2%)	125
Levofloxacin	38 (35.19%)	70 (64.81%)	108
Pefloxacin	04 (100%)	00	04
WHO Reserve Group antibiotics			
Aztreonam	03 (33.33%)	06 (66.67%)	9
Colistin	90 (95.74%)	04 (4.26%)	94
Linezolid	01 (100%)	00	01
Tigecycline	55 (98.21%)	01 (1.79%)	56
Unclassified			
Nalidixic acid	00	99 (100%)	99

WHO: World Health Organization

Completely Effective Antibiotics (100% Sensitivity): Imipenem (100% S), Meropenem (100% S), Netilmicin (100% S), Amikacin (100% S) were completely sensitive against gram negative uropathogens. (Table II)

Highly Effective Antibiotics (80-99% Sensitivity): Tigecycline (98.21%), Gentamicin (97.64% S), Colistin (95.74% S), Cefepime (87.5% S), Nitrofurantoin (82.81% S), Cefotaxime (80.37% S) showed the high sensitivity rates, indicating their strong efficacy against Gram-negative uropathogens. (Table II)

Moderately Effective Antibiotics (50–79% Sensitivity): Ceftriaxone (77.34% S), Piperacillin-tazobactam (73.68% S), Ceftazidime (67.57% S), and Cefixime (65.63% S) displayed moderate efficacy, suggesting their potential use depending on the clinical condition. (Table II)

Poorly Effective Antibiotics (1-50% Sensitivity): Ciprofloxacin (40.8%), Levofloxacin (35.19%), Aztreonam (33.33% S), Cefuroxime (19.17%), Ampicillin (16.66% S), Doxycycline (14.15% S), Amoxyclav (12.30%), Cotrimoxazole (7.2%), and Cephradine (1.56%) exhibited poor efficacy, indicating their limited therapeutic use. (Table II)

Complete Resistant antibiotics (0% Sensitivity): Nalidixic acid, Tetracycline and Cefoperazone showed complete resistance (100% R) against Gram negative uropathogens. (Table II)

Unconfirmed: Due to very low (<5) cases, sensitivity of Fosfomycin, Cefalotin, Linezolid and Pefloxacin could not be confirmed. (Table II)

Completely Resistant Antibiotics (100% Resistance): Penicillin (100% R), Cefoperazone (100% R), Cephradine (100% R), Azithromycin (100% R), Clindamycin (100% R), and Nalidixic acid (100% R) were completely resistant against gram positive organisms. (Table III)

Highly Resistant Antibiotics (80-99% Resistance): Cefixime (85.71% R), Cefuroxime (85.71% R), and Levofloxacin (80% R) showed high resistance, indicating limited therapeutic use. (Table III)

Moderately resistant Antibiotics (50–79% Resistance): Cotrimoxazole (75% R), Ceftriaxone (71.43% R), Cefotaxime (66.67% R), Ceftazidime (66.67% R) Ciprofloxacin (62.5% R) displayed moderate resistance, suggesting their potential use depending on the clinical condition. (Table III)

Table III: Antibiotic sensitivity and resistance pattern of isolated gram-positive uropathogens (n=09)

	Sensitive (S) n (%)	Resistant (R) n (%)	Total n
WHO Access Group antibiotics			
Ampicillin	04 (57.14%)	03 (42.86%)	07
Penicillin	00	04 (100%)	04
Amoxyclav	06 (85.71%)	01 (14.29%)	07
Cephradine	00	03 (100%)	03
Nitrofurantoin	06 (100%)	00	06
Amikacin	04 (100%)	00	04
Gentamicin	07 (100%)	00	07
Clindamycin	00	04 (100%)	04
Doxycycline	05 (71.43%)	02 (28.57%)	07
Cotrimoxazole	02 (25%)	06 (75%)	08
WHO Watch Group antibiotics			
Vancomycin	07 (100%)	00	07
Cefixime	01	06 (85.71%)	07
Cefuroxime	01	06 (85.71%)	07
Ceftriaxone	02 (28.57%)	05 (71.43%)	07
Cefoperazone	00	01 (100%)	01
Ceftazidime	02 (33.33%)	04 (66.67%)	06
Cefepime	02 (100%)	00	02
Cefotaxime	02 (33.33%)	04 (66.67%)	06
Imipenem	02 (100%)	00	02
Meropenem	03 (100%)	00	03
Teicoplanin	01 (100%)	00	01
Netilmicin	03 (100%)	00	03
Azithromycin	00	03 (100%)	03
Ciprofloxacin	03 (37.5%)	05 (62.5%)	08
Levofloxacin	01 (20%)	04 (80%)	05
Rifampicin	01 (100%)	00	01
WHO Reserve Group antibiotics			
Linezolid	07 (100%)	00	07
Daptomycin	01 (100%)	00	01
Tigecycline	03 (100%)	00	03
Unclassified			
Nalidixic acid	00	02 (100%)	02

WHO: World Health Organization

Poorly resistant Antibiotics (1-50% Resistance): Ampicillin (42.86% R), Doxycycline (28.57% R), and Amoxiclav (14.29% R), exhibited poor resistance, indicating their strong efficacy. (Table III)

No Resistance (0% Resistance): Linezolid, Vancomycin, Gentamicin, Nitrofurantoin, Amikacin, Meropenem, Imipenem, and Netilmicin had no resistant cases, suggesting strong efficacy but requiring further confirmation. (Table III)

Discussion

UTI still remains one of the leading causes of illness and mortality in developing countries such as Bangladesh. This could be due to a lack of proper research, incorrect diagnostic process, misuse of chemotherapeutic medicines etc.[27] The purpose of this study was to find out the bacteriological profile and their antibiotic susceptibility pattern in patients with UTI according to the WHO AWaRe classification in a diagnostic center in Narayanganj district of Bangladesh.

In the present study, 48.75% (137/281) had positive bacterial growth. This growth rate is almost similar to previous study conducted by Semwal et al., 2017 in Uttarakhand, India where it was 49.11%.28 But, unlike the present study, many other studies that are done in Dhaka (40.14%) and Mumbai (33.54%), lower growth rates were observed.[27,28] Some authors also reported the positive culture rate to be 55.08% and 71% in Dhaka city.[9,24] One reason for this higher growth rate of uropathogens in Dhaka city[9] and in the present study in Narayanganj district may be due to patients with poor personal hygiene and sanitation facilities coming from rural catchment areas. Another reason may be due to larger sample size (3200/4500).[24]

The results showed a higher growth positivity rate in females (69.60%) compared to males (25.56%), that indicate a sex-based difference in UTI prevalence, which is similar to previous findings.[27,30,32,33] Females are more prone to UTI as compared to males due to the short urethra, easy exposure of the tract with fecal matter, absence of prostatic secretion, pregnancy, obstruction and sexual activity.[34,35]

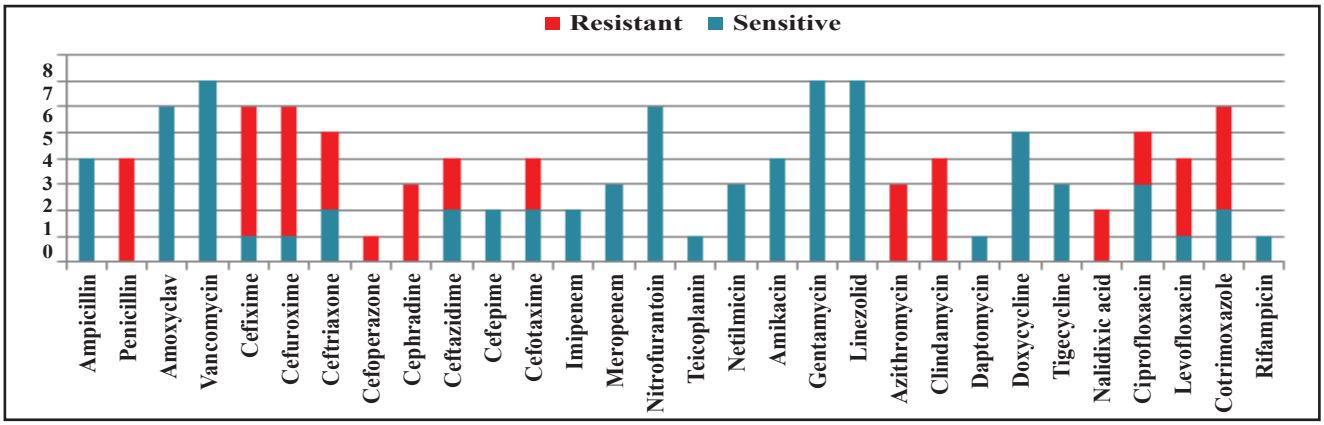

Figure 3: Antibiotic sensitivity and resistance profiles of isolated gram-positive uropathogens (n=09)

In the present study, Gram-negative bacteria, particularly E. coli, were the most common isolates (78.8%). It was similar to the findings of other studies done by Zannat et al (77.14%) and Sharmin et al. (74.1%).[31,36] E. coli is the leading cause of urinary tract infections (UTIs) because it naturally is present in the human gut, making it readily transferable to the urethral opening, especially in women due to the close proximity between the anus and urethra, and certain strains of E. coli have specific virulence factors that allow them to attach to the bladder lining and cause infection within the urinary tract.[37] The increased incidence of Klebsiella (12.4%) and Pseudomonas (2.2%), is also consistent with earlier observations.[24]

Gram-positive bacteria are less prevalent among community-acquired UTIs.[38] In this study, Gram-positive organisms, Staphylococcus aureus (3.6%) and Enterococci (2.9%) being the most frequently isolated species, comparable to earlier research.[1]

The antibiotic resistance patterns revealed in this study are alarming because they reflect the larger worldwide trend of growing resistance in UTI bacteria.[39] The Gram-negative bacteria were highly resistant to WHO Access group antibiotics like Tetracycline, Cephradine, Cotrimoxazole, Amoxyclav, Doxycycline & Ampicillin but, showed highest susceptibility to Amikacin, Gentamicin & Nitrofurantoin (Table II). These antibiotics are first-or second-choice for the treatments of the most common bacterial infections. They have lower possibility of developing resistance.[40] But, increasing resistance to them in this study is a direct reflection of overuse and misuse of these antibiotics.[41]

The Gram-negative bacteria were highly resistant to two of the commonly used WHO Watch group antibiotics (Cefuroxime & Cefoperazone) but, showed reliable susceptibility for rest of the antibiotics (Imipenem, Meropenem, Pefloxacin, Cefepime & Cefotaxime) (Table II). They have higher resistance potential and their use should be restricted.[40]

The Gram-negative bacteria were moderately resistant to WHO Reserve group antibiotics also like Aztreonam while showed highest susceptibility to Tigecycline & Colistin (Table II). These are reserved for severe & complex infections caused by multidrug-resistant uropathogens and should only be used when all other antibiotics have failed.[40]

Isolated gram-positive bacteria also were highly resistant to Penicillin, Cefoperazone, Cephradine, Azithromycin, Clindamycin, & Nalidixic acid (Table III). Gram-positive bacteria showed excellent susceptibility to Linezolid, Vancomycin, Nitrofurantoin, Amikacin, Meropenem, Imipenem, and Amoxiclav (Table III).

Both Gram-positive and Gram-negative uropathogens showed high rates of resistance, which is consistent with earlier research concerning the rising incidence of multidrug-resistant infections.[27-36,39,43] The findings of this study emphasize the need for regular and regional surveillance of antimicrobial resistance patterns. The significant resistance rates revealed in this study indicate the need of giving specific antibiotics based on culture and sensitivity testing rather than relying entirely on empirical therapy.[29]

According to International guidelines, Nitrofurantoin, Cotrimoxazole, and β-lactam, Fluoroquinolones antibiotics are recommended as first-line and second-line therapy, respectively, for the treatment of UTI.[42] Though, Nitrofurantoin showed excellent efficacy but, Cotrimoxazole, some of the β-lactams and Fluoroquinolones showed considerable resistance in the present study, which supports the earlier findings of increasing resistance in UTI.[32,36,43]That's why, their present recommended use in guidelines as a first- and second-line treatment for UTI, may need to be reconsidered. WHO Reserve group antibiotics showed excellent susceptibility against uropathogens in this study. Widespread use of these reserve antibiotics should be strictly controlled to ensure their rational use only for treating MDR-UTIs.[41,44]

UTIs pose a serious burden for the National Health Service.[45] The findings point to the need of instituting antimicrobial stewardship programs, especially in healthcare centers, to ensure judicious use of antibiotics and slow down the spread of resistance.[46] Besides, these results highlight the need for public health initiatives such as creating awareness on WASH (Water, Sanitation & Hygiene) and hydration to prevent UTIs.[47]

There are some limitations in this study. For example, standard ATCC strains were not used for antimicrobial susceptibility testing quality control. Also, demographic data (residence, socioeconomic status, literacy etc.) and clinical information (community acquired/ nosocomial, complicated/ uncomplicated) of patients could not be collected. Besides, level of awareness of the patients about health, hygiene & hydration could not be known.

Conclusion

This study provides important insights into the prevalence, microbiological etiology, and antibiotic resistance patterns of urinary tract infections (UTIs). Increasing resistance of uropathogens to first line therapy (e.g. Cotrimoxazole), and second line therapy (e.g. some of the β-lactams, fluoroquinolones) of UTI has been a significant concern for us. So, in addition to Nitrofurantoin; Amikacin & Gentamicin from the WHO Access group and Cefepime, Cefotaxime, Ceftriaxone & Pefloxacin from the WHO Watch group, may be prioritized for the treatment of UTI due to their excellent efficacy. Also, antibiotics from the WHO Watch group and Reserve group should be used for UTI treatment, but only with caution and rationale. As the antibiotic susceptibility pattern of uropathogens differs according to time and geographical locations, continued surveillance of antibiotic resistance should be done to ensure the selection of the best empiric treatment for UTI.

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