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Original Research Article

Assessment of the Antimicrobial Sensitivity Pattern of Bacterial Pathogens Causing Uncomplicated Urinary Tract Infection in Female Patients at a Tertiary Level Hospital

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Abstract: ***Introduction:*** Urinary tract infection (UTI) is a common infectious disease which affects both, men and women. It is a significant health concern due to multidrug-resistant (MDR) organisms. Therefore, it is necessary to have a current understanding of the antibiotic susceptibility (AS) pattern of uropathogens to manage UTI effectively. ***Objective:*** This study aims to assess the antimicrobial sensitivity pattern of bacterial pathogens causing uncomplicated urinary tract infection in female patients. ***Methods:*** A prospective study was conducted at the Department of Pharmacology & Therapeutics in collaboration with the Department of Microbiology at SBMC, the Outpatient Department of Medicine, and Gynae & Obstetrics at Sher-E-Bangla Medical College, Barishal, Bangladesh, from January 2017 to December 2017. Clean catch midstream urine samples were collected and processed using standard guidelines for microbiological procedures. Positive microbiological cultures were found in 200 of the 314 patients, Data on socio-demographic, clinical, and risk factors were collected using a structured questionnaire. ***Results:*** In this study, the age of the subjects ranged from 15 to 75 years, majority of subjects (38.4%) belonged to age group of 45-60 years. The mean age was found 42.6±11.4 years. Out of 200 cases, E. coli was the most predominant gram-negative bacteria. Antibiotic susceptibility testing revealed that the pathogenic bacteria isolated from urine samples were MDR organisms. Aminoglycoside antibiotics such as Amikacin and gentamycin were the most effective drugs. ***Conclusion:*** Urinary tract infections are prevalent, affecting 64% of cases, with all isolates showing resistance to commonly used antibiotics. Therefore, it is recommended to provide health education on the transmission and causes of urinary tract infections.

Keywords: Urinary tract infection, Antibiotic susceptibility, E. Coli, antibiotic resistance, antibiotics.

INTRODUCTION

Urinary tract infections (UTIs) are inflammatory conditions caused by an overgrowth of microorganisms in the urinary system [1]. UTIs can cause short-term issues such as fever, painful urination, and lower abdominal pain, and may lead to permanent kidney scarring [2]. UTIs can be community-acquired or hospital-acquired (HA). Infection originates in individuals within the community (within 48 hours of admission) or in a hospital setting [3]. HA-UTI occurs 48 hours after hospitalization and is not present at admission or within 3 days of discharge [4, 5]. UTIs can be asymptomatic or symptomatic, putting pressure on public health systems and reducing quality of life [6]. Urinary tract infections are more common in women than in men due to the anatomical proximity of the urethra to the gastrointestinal opening [7]. The most common bacteria causing UTI are Escherichia coli, Klebsiella pneumoniae, Staphylococcus, Proteus, Pseudomonas aeruginosa, Enterococcus, and Enterobacter, with variations in their prevalence order [8-10].

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Approximately 150 million UTI cases are diagnosed globally each year, resulting in at least $6 billion in healthcare costs [11, 12]. Susceptibility data from local microbiological facilities aid in the empirical selection of antibiotics for UTI treatment. However, these data are limited to complicated UTIs, as uncomplicated UTI specimens are seldom sent to laboratories [13]. UTIs are often treated empirically, especially in rural areas where urine culture is not available, leading to antibiotic misuse [14]. The increasing prevalence of drug resistance among uropathogens is a significant public health concern, requiring regular antibiotic susceptibility (AS) screening for organisms causing UTI [15]. In addition, antimicrobial sensitivity for bacteria causing UTIs varies over time and by location. Therefore, it is crucial to screen for susceptibility in each location to generate current epidemiological data [8, 16]. Unfortunately, the resistance profile of community-acquired uropathogens in various geographical regions of India has not been adequately investigated [17, 18]. Since UTIs are often treated empirically in regions without microbiological facilities, treatment is based on anticipated pathogens and their antibiotic susceptibility patterns specific to the geographic area. This study aims to assess the antimicrobial sensitivity pattern of bacterial pathogens causing uncomplicated urinary tract infections in female patients at a tertiary hospital. Ethical clearance and well-informed written consent were assured before the study.

Objectives

- *General objective:* The objective of this research is to study the pattern of uropathogens causing urinary tract infections.
- *Specific objective*: This study aims to assess the antimicrobial sensitivity pattern of bacterial pathogens causing uncomplicated urinary tract infections in female patients. in a tertiary care hospital.

METHODOLOGY

This prospective study includes 200 outpatients, who visited the Department of Medicine, and Gynae & Obstetrics, SBMCH, Barishal with the symptoms of UTI from January 2017 to December 2017.

- *Inclusion criteria:* This study involves patients based on rigorous screening with clinical features of urinary tract infection (UTI), female patients who are taking antibiotics. The patients were aged more than 15 years. They signed informed consent for inclusion in the study.
- *Exclusion criteria*: The study excluded patients who were under the age of 15, those with polymicrobial infections involving more than two bacterial species, patients with Candida sp. as the sole pathogen or with bacteria, pregnant females with asymptomatic bacteriuria, and those who had previously been on antibiotic therapy.

The data was analyzed using descriptive statistics to determine the prevalence of UTIs, frequency of uropathogens, antimicrobial susceptibility profile, and P value < 0.005 was counted as significant. All statistical tests were performed using SPSS software version 23 and Microsoft Excel 2016 (Microsoft Corporation, Redmond, WA, United States). The antimicrobial susceptibility test was conducted using the Kirby–Bauer disk diffusion method and interpreted according to Clinical Laboratory Standards Institute (CLSI) guidelines (Table-1). Bacterial isolates were identified based on standard microbiological techniques, including culture and biochemical characteristics. A sterile calibrated loopful of urine samples was plated on sheep blood agar (SBA) and MacConkey agar (MA) to isolate bacterial uropathogens and incubated at 37°C for 24 hours. The ethical review committee of SBMCH, Barishal, has approved the study. Patients also provided well-informed written consent.

RESULT

The study includes patients of 15 years to 75 years old with the mean age of 42.6±11.4. 83.2% of the study patients were married and 80% of patients belonged to rural areas [Table-2]. According to Table-3, E. coli is the most dominating bacterial pathogen for both of the age groups 15 to 45 years and 46 to 75 years, 57.17% and 51.5% respectively. Staphylococcus epidermidis is the least concerning one, 2.88% and 2.02%. Amikacin was effective against 77.0% of E. coli, 73.9% of Proteus species, 81.8% of K. pneumoniae, 52.9% of E. cloacae, 90.5% of Citrobacter species, and 76.2% of P. aeruginosa. Gentamicin showed a similar level of efficacy with susceptibility rates of 49.7% for E. coli, 56.5% for Proteus species, 86.4% for K. pneumoniae, 52.9% for E. cloacae, 81.0% for Citrobacter species, and 81.0% for P. aeruginosa. Ceftriaxone inhibited 42.9% of Citrobacter species isolates. The two carbapenem antibiotics also performed poorly, with meropenem showing efficacy against 52.4% of Citrobacter species but less than 50% of the other gram-negative isolates. Nitrofurantoin, vancomycin, and chloramphenicol were particularly effective against gram-positive bacteria. Vancomycin, an antibiotic with restricted prescription, was found to inhibit 100% of Staphylococcus species and 72.2% of Enterococcus species. Nitrofurantoin was also found to be effective against 94.4% of Enterococcus species, 70.0% of S. aureus, and 100% of S. epidermidis.

Table-1 Antibiotics used against different isolated uropathogens

Antibiotics groups		**Antibiotic**
Beta-lactams	Penicillin	Ampicillin
		Penicillin Piperacillin
		Ampicillin
	Cephalosporin	Cefepime
		Ceftazidime Ceftriaxone
		Cefepime
		Cefoxitin
	Carbapenem	Aztreonam
		Meropenem Imipenem
		Aztreonam
Beta-lactamase inhibitors	Piperacillin-Tazobactam	
	Ceftazidime-Clavulanic Amoxicillin-clavulanate (Amoxyclav)	
	Piperacillin-Tazobactam	
Fluoroquinolones	Norfloxacin	
	Ciprofloxacin	
Aminoglycosides	Gentamycin	
	Amikacin Gentamycin (120) Tobramycin Netilmicin	
	Gentamycin	
	Amikacin Gentamycin (120) Tobramycin Netilmicin	
	Gentamycin	
Glycopeptide	Vancomycin	
	Teicoplanin	
Tetracycline	Doxycycline	
	Tetracycline	
Others	Clindamycin	
	Chloramphenicol	
	Linezolid	
	Erythromycin	
	Nitrofurantoin	
	Co-trimoxazole	

Table-2: Demographic characteristics of the study population

Characteristics		**Frequency**	**Percentage**
Age	15-30	70	22.4%
	31-44	114	36.48%
	45-60	120	38.4%
	60-75	18	5.76%
	Mean± SD	42.6±11.4	
	Range	18-75	
Marital status	Single	54	17.28%
	Married	260	83.2%
Residence	Urban	64	20.48%
	Rural	250	80%

Table-3: Distribution of bacteria in the study population

Bacterial pathogens	**15–45 years (n=101)**	**46–75 years (n=99)**	**P value**
Escherichia coli	57.17%	51.5%	0.039*
Proteus sp.	7.2%	8.08%	
Klebsiella pneumoniae	5.23%	8.08%	
Pseudomonas aeruginosa	5.76%	5.04%	
Citrobacter sp.	5.77%	6.06%	
Staphylococcus aureus	6.7%	6.07%	
Enterococcus sp.	3.83%	6.06%	
Enterobacter cloacae	4.32%	7.06%	
Staphylococcus epidermidis	2.88%	2.02%	

Table-4: Susceptibility of different antibiotics against isolated gram-negative and gram-positive uropathogens

Antibiotics	***E. coli (83)***	***Proteus (20)***	***K. pneumonia (17)***	***E. cloacae (15)***	***Citrobacter (21)***	***P. aeruginosa (15)***	***Enterococcus (18)***	***S. aureus (8)***	***S. epidermidis (3)***
	Gram-negative uropathogens						**Gram-positive uropathogens**		
Amikacin	77.0%	73.9%	81.8%	52.9%	90.5%	76.2%	NT	NT	NT
Gentamycin	49.7%	56.5%	86.4%	52.9%	81.0%	81.0%	NT	NT	NT
Tobramycin	NT	NT	NT	NT	NT	71.4%	NT	NT	NT
Ampicillin	1.1%	8.7%	0.0	0.0	23.8%	NT	66.7%	NT	NT
Amoxy-clav	12.6%	0.0	18.2%	5.9%	4.8%	NT	NT	NT	NT
Piperacillin	NT	NT	NT	NT	NT	23.8%	NT	NT	NT
Piperacillintazobactum	37.7%	52.2%	45.5%	23.5%	71.4%	71.4%	NT	NT	NT
Ceftazidime	12.0%	26.1%	54.5%	17.6%	33.3%	23.8%	NT	NT	NT
Cefepime	6.6%	8.7%	22.7%	23.5%	9.5%	38.1%	NT	NT	NT
Ceftriaxone	16.9%	26.1%	40.9%	35.3%	42.9%	NT	NT	NT	NT
Co-trimoxazole	39.8%	34.7%	86.4%	35.3%	52.4%	NT	NT	20.0%	37.5%
Ceftazidime Clavulanic acid	45.9%	NT	0.0	NT	NT	NT	NT	NT	NT
Imipenem	57.4%	13%	72.7%	29.4%	57.1%	90.5%	NT	NT	NT
Meropenem	37.2%	13%	40.9%	29.4%	52.4%	23.8%	NT	NT	NT
Nitrofurantoin	49.7%	21.7%	13.6%	17.6%	61.9%	0.0	94.4%	70.0%	100.0%
Penicillin	NT	NT	NT	NT	NT	NT	33.3%	0.0%	12.5%
Cefoxitin	NT	NT	NT	NT	NT	NT	NT	15.0%	25.0%
Norfloxacin	4.4%	13.0%	13.6%	0.0%	23.8%	66.7%	33.3%	10.0%	37.5%
Ciprofloxacin	3.8%	21.7%	22.7%	5.9%	28.6%	71.4%	44.4%	10.0%	37.5%
Clindamycin	NT	NT	NT	NT	NT	NT	NT	55.0%	62.5%
Erythromycin	NT	NT	NT	NT	NT	NT	11.1%	5.0%	25.0%
H-gentamycin	NT	NT	NT	NT	NT	NT	66.7%	NT	NT
Netilmicin	NT	NT	NT	NT	NT	NT	NT	25.0%	75.0%
Novobiocin	NT	NT	NT	NT	NT	NT	NT	70.0%	87.5%
Tetracycline	NT	NT	NT	NT	NT	NT	38.9%	NT	NT
Doxycycline	NT	NT	NT	NT	NT	NT	NT	40.0%	50.0%
Teicoplanin	NT	NT	NT	NT	NT	NT	83.3%	NT	NT
Vancomycin	NT	NT	NT	NT	NT	NT	72.2%	100.0%	100.0%
Linezolid	NT	NT	NT	NT	NT	NT	88.9%	NT	NT
Chloramphenico	NT	NT	NT	NT	NT	NT	88.9%	75.0%	87.5%

**NT: Not tested

DISCUSSION

The etiology, pathophysiology, and antimicrobial susceptibility patterns of uropathogens have changed over time and location, and this trend will continue in the future [8]. Identification of the organism and its antimicrobial susceptibility is crucial for managing UTI. It highlights the importance of close collaboration and cooperation between the clinician and the microbiologist [19]. This study aimed to evaluate the level of antimicrobial resistance among uropathogens and compare the situation in the Prayagraj region, which is located in the eastern part of North India. In our study, the prevalence of urinary tract infections (UTI) was found to be 79.9%. This high prevalence rate is notable as compared to previous studies, which reported rates of 45.7%, 53.8%, 65.4%, and 37.3% in India. It's worth noting that our study's inclusion criteria were based on rigorous screening through a questionnaire administered by clinicians, while the previous studies used symptom-based criteria [13, 20, 9, 21]. Our investigation found a high prevalence of UTI, similar to a study in the Mexican population where 97.3% of patients excreted significant uropathogens, and in Ethiopia, where 90.1% of patients showed significant growth of uropathogens [22, 23]. Studies have shown that females experience UTIs more frequently than males [13, 24, 1]. Our findings confirm previous research showing a higher prevalence of UTIs in females (60.7%) compared to males (39.3%). This difference can be attributed to the proximity of the female urethral opening to the anus, the shorter length of the female urethra, sexual intercourse, incontinence, and improper toilet habits [13]. In our study, we found that young females between the ages of 18 and 50 (reproductive age) have a higher incidence of UTIs. This is consistent with findings from studies conducted in Meerut (age 26–36, 90.7%), Jaipur (age 21–50, 41.3%), and Ethiopia (age 20–29, 37.5%). The female anatomy in this age group makes them more vulnerable and prone to this disease [17, 13, 23]. However, our study also revealed that elderly males (51–80 y) had a higher incidence of UTI (35.9%) than elderly females (25.7%). These findings mirrored studies conducted in Jaipur (Rajasthan), 47.3%; Meerut (Uttar Pradesh), 71.2%; Sonipat (Haryana), 58.3% of India [17, 13, 1].

The higher incidence of UTI in elderly males may be attributed to the increased prevalence of benign prostate enlargement and neurogenic bladder [25]. Other researchers supported these findings, stating that prostate disease in elderly males contributes to the higher incidence of UTI [26]. The most common gram-negative bacteria isolated from samples in our investigation was E. coli (55.0%). These findings are consistent with those of several other published studies, where the prevalence of E. coli was found to be 97.0%, 92.6%, 74.0%, 55.0%, 49.3%, 43.5%, 41.9%, and 40.0% [27, 24, 28, 16, 29, 30, 31, 32]. In our study, Proteus sp. (6.9%) and K. pneumoniae (6.6%) were the second and third most frequently reported bacteria, followed by P. aeruginosa (6.3%) and Citrobacter sp. (6.3%). Proteus sp. colonizes the gastrointestinal tract of humans and causes UTI by ascending from the rectum to the urethral tissue and the urinary bladder. The increased prevalence of gram-negative bacteria from the Enterobacteriaceae family causing UTI can be attributed to several factors, including adherence to the uroepithelium due to urogenital mucosa colonization via adhesins, pili, fimbriae, and P-1 blood group phenotypic receptor [33]. P. aeruginosa is an uncommon uropathogen primarily responsible for catheter-associated UTIs in adults. Its presence as the second most common isolate (3/18, 16.7%) in the age group of 7–18 years requires further exploration [34]. It has been suggested that children with a history of previous UTI episodes, hospitalization, antibiotic use, malformations predisposing to UTIs, vesicourethral reflux, abnormal DMSA (dimercaptosuccinic acid) scan, longer hospitalization, and surgery are more susceptible to P. aeruginosa UTIs. The emergence of Citrobacter sp. as a uropathogen, especially in the age group over 80 years, which is resistant to the majority of antibiotics, is alarming. Citrobacter sp. should no longer be overlooked as a commensal, and proper surveillance in antimicrobial sensitivity testing must be conducted [35]. In our study, 96.0% of the pathogens were multi-drug resistant (MDR), compared to 91.3% in Nepal, 85.5% in Somaliland, 83.0% in Haryana, 45.1% in Tunisia, and 42.6% in China [36, 30, 1, 37, 29]. The overuse of broad-spectrum antibiotics and prolonged hospital stays are key factors associated with MDR infections [38]. In our study, 40.4% of E. coli were found to produce ESBLs, while other publications reported percentages of 25.2%, 35.7%, 46.0%, and 52-67% [39, 30, 40, 41]. ESBL producers hydrolyze and eliminate the majority of broad-spectrum beta-lactam antibiotics, increasing morbidity and mortality [42]. ESBL-producing bacteria do not easily hydrolyze carbapenems; therefore, they are commonly used as first-line therapy in clinical settings. However, overuse of carbapenems may complicate the treatment of this type of bacterium [39]. The results of the antibiotic susceptibility testing showed that amoxy-clav, ampicillin, and cefepime were the least effective drugs against all the identified gram-negative bacteria. On the other hand, amikacin, gentamicin, and imipenem were found to be the most effective drugs for treating gram-negative bacteria. These findings are in line with previous research conducted by other authors in Sonipat (Haryana) and Meerut (UP) [13, 1]. In our study, tobramycin exhibited promising sensitivity to P. aeruginosa; however, a study conducted in Meerut found that 60.0% of P. aeruginosa were resistant to tobramycin [13]. In our study, imipenem and meropenem displayed poor antimicrobial activity against gram-negative bacteria, in contrast to previous investigations where carbapenem susceptibility was greater than 80.0% [9, 1]. Several studies have indicated resistance to the beta-lactam group of antibiotics, cephalosporins, and fluoroquinolones. Our investigation also revealed a significant decrease in sensitivity patterns [17, 21, 1]. Furthermore, in our study, nitrofurantoin showed significant susceptibility to E. coli but not to other Enterobacteriaceae (except Citrobacter sp.), which is consistent with a study conducted in Jaipur [17]. It is likely due to the irrational use of antibiotics in the past, with insufficient dose and duration. In our study, antibiotics showed significantly high sensitivity rates to gram-positive bacteria, which aligns with investigations conducted by other authors [17, 9].

Limitations

This was a single-centre study with a small population for a longer period causing data loss and not providing the overall scenario of the county. It is presumable, due to irrational use of it in the past with insufficient dose and duration antibiotics may show considerably high sensitivity rates to gram-positive bacteria in this study.

CONCLUSION

According to present study, resistance to bacterial uropathogens is becoming a public health issue. The findings highlight the importance of understanding local antibiotic resistance patterns, which can be used to develop hospital and regional antibiotic policies. To prevent or control the emergence of antibiotic resistance in bacteria, the government should implement laws that mandate the careful use of these antibiotics.

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Conflicts of interest: N/A

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