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Causative Organisms and Antimicrobial Sensitivity Pattern in Patients with Urinary Tract Infection

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ABSTRACT

Patterns of pathogens in urinary tract infection (UTI) and antibiotic sensitivity have been scarcely studied in the recent past in local settings. Hence, the study has been planned to address the knowledge gap arising from the non-availability of recent data. **Objectives:** To evaluate the causative organisms and antimicrobial sensitivity patterns in patients with urinary tract infections. **Methods:** This descriptive cross-sectional study was carried out at the Medicine Department of Khyber Teaching Hospital, Peshawar, during the period 1st July 2022 till 31st December 2022. Male and female patients aged 20 to 80 years with culture-proven urinary tract infections were enrolled. Pathogens isolated were noted their sensitivity to antibiotics was assessed.Data were analyzed using SPSS version 26.0. **Results:** The majority of study participants were aged more than 50 years (n=92, 51.4%). 109 patients (60.9%) were male, and 85 patients (47.5%) were diabetic.89 patients (49.7%) were enrolled from the Outpatient Department. The most common pathogen was E coli, recorded in 48 patients (26.8%). Isolates in 154 (86.0%) out of 179 participants were susceptible to nitrofurantoin, followed by meropenem in 151 (84.3%). **Conclusions:** It was concluded that people of all ages can be affected by urinary tract infection.The most common bacterial cause of UTI is E coli.Nitrofurantoin and meropenem are the most effective antibiotics against uropathogens.

INTRODUCTION

Urinary tract infections (UTI) range in clinical manifestation from subclinical to catastrophic sepsis, are among the most prevalent bacterial infections in regular healthcare settings [1]. UTIs rank second in terms of hospitalizations and are among the leading causes of illness in people of all ages [2]. In numerous medical facilities, it serves as an extremely prevalent nosocomial illness, accounting for around 35% of all infections contracted in hospitals [3]. This expense has a major negative influence on people's financial lives and contributes significantly to the usage of antibacterial medications [4]. A novel category of infectious diseases caused by resistance to medication was once more exemplified by the microbes that continued to transmit diseases despite the use of these more recent antibiotics [5]. As a result of their novel genetic changes, bacteria are expected to ultimately acquire greater resistance. A variety of pathogens have been isolated, leading to UTIs in both the community and hospitals. The majority of them constitute the normal flora of the human gut, making it simple to colonize the urinary system. The majority of community-acquired UTIs are mild, optimally occupying the bladder and leading to cystitis [6]. Microbial resistance to medications is a major problem in the management of infectious illnesses worldwide. The

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improper application of antibiotics in medical care has led to an increase in microbial resistance [7]. The ensuing proliferation of bacterial resistant strains is a serious healthcare concern. The risk of severity is decreased by early UTI therapy, indicating that empirical antibiotic prescription is usually given. Providing an efficient empirical regimen requires knowledge of the main bacteria frequently linked to urinary tract infections and their distinctive forms of antibiotic resistance [8]. This procedure makes it possible to restrict the spread of resistant bacterial strains and the worldwide public health concern of antibiotic resistance [9]. Updated knowledge about the pattern of pathogens and antibiotic sensitivity is vital for improved outcomes without increasing the risk of antibiotic resistance. In a study by Gul *et al.*, the most frequent symptoms included fever, loin discomfort, and uneasiness brought on by pain. E. coli accounted for 65.1% of all isolated organisms, with E. fecalis coming in second (20.8%). Vancomycin, Amikacin, Nitrofurantoin, and imepenim had strong sensitivity in terms of sensitivity pattern, but Ceftriaxone and Ampicillin displayed the highest resistance [10]. In another study by Anwar *et al.*, E. Coli was the most common cause of UTIs (40.6%), followed by Actinobacter spp, Staph aureus, Klebsiella spp and Enterococcus spp. Ceftriaxone, moxifloxacin, ampicillin and cefazolin were most effective against E coli. Other sensitive antibiotics included sulzone, fosfomycin and imepenim group [11]. The spectrum of bacterial pathogens and antibiotic sensitivity in patients with urinary tract infection is very broad. Moreover, the pattern of pathogens and antibiotic sensitivity has seldom been studied in the recent past in local settings. Hence, the study has been planned to address the knowledge gap arising from the non-availability of recent data. Moreover, the study would provide useful information regarding the bacterial agent's patterns and trends in antibiotic sensitivity among patients with urinary tract infections.

The study aims to evaluate the causative organisms and antimicrobial sensitivity patterns in patients with urinary tract infections.

METHODS

This descriptive cross-sectional study was carried out at the Department of Medicine, Khyber Teaching Hospital, Peshawar, during the period 1st July 2022 till 31st December 2022, after taking approval from the hospital IRB vide no: 36/DME/KMC. Male and female patients in the age range of 20 to 80 years diagnosed with urinary tract infection were enrolled. Patients with a history of antibiotic intake in the last 4 weeks, immune-compromised patients, and patients with KUB stones, chronic kidney disease on ultrasound, catheterized patients and pregnant females were excluded. Urinary tract infection was defined when the patient was complaining of fever (body temperature >38.0°C on thermometer) and urine R/E showing more than 10 pus cells/mm3 or more than 5 red cells/mm3. Bacterial pathogens were broadly classified as gram-negative pathogens, including E coli, Proteus, P. aeruginosa and Klebsiella, and gram-positive pathogens included Staphylococcus species, Enterococci and Streptococcus species. Antibiotic spectrum included Penicillins, cephalosporins, macrolides, fluoroquinolones and nitrofurantoin. Antibiotic sensitivity was assessed using the minimum inhibitory concentration (MIC) test. Antibiotics were said to be sensitive when MIC inhibit the growth of pathogens, and failure to inhibit the growth of pathogens was called resistance. The sample size was 179, calculated using an anticipated value for E coli as the cause of UTI=65.1%, margin of error=7% and confidence level=95% [10]. Participants were enrolled using a non-probability convenience sampling method. Informed consent was obtained from patients satisfying selection criteria and willing to participate in the study. Participants were enrolled from the indoor and out departments. Baseline characteristics like age, gender, BMI, duration of fever (days), comorbidities like diabetes and hypertension, residence, education, profession and SE status were noted. A 10cc mid-urine sample was collected in an air-tight plastic container. The sample was sent to the hospital lab for culture and sensitivity. Culture was grown using various media. Any growth was recorded. The organisms were exposed to various antibiotics at various amounts, and inhibition/non-inhibition of colony growth in the culture was noted to record the sensitivity pattern of antibiotics. Data were recorded and analyzed using SPSS version 26.0. Means ± SD were recorded for continuous data, and frequencies and percentages were recorded for categorical data. Bacterial pathogens and patterns of antibiotic sensitivity were recorded. Contingency table analysis was carried out between pathogens and antibiotic sensitivity. Bacterial pathogens were stratified by various clinic-demographic parameters to control for effect modifiers. Post-stratification chi-square test was applied at a 5% level of significance.

RESULTS

The mean age of the participants was 49.93 ± 16.03 years, the mean BMI was 23.941 ± 1.702 kg/m2, and the mean complaints duration was 8.043 ± 1.480 days. The majority of study participants were aged more than 50 years (n=92, 51.4%). 109 patients (60.9%) were male, and 85 patients (47.5%) were diabetic. 89 patients (49.7%) were enrolled from the Outpatient Department (Table 1).

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Table 1: Descriptive Statistics and Baseline Features of the Study Cohort (n=179)

Parameters	Subgroups	Frequency (%)
Age (Years)	50 or Below	87 (48.6%)
	Above 50	92 (51.4%)
BMI (kg/m^2)	24.0 or Below	101 (56.4%)
	More Than 24.0	78 (43.6%)
Gender	Male	109 (60.9%)
	Female	70 (39.1%)
Diabetes	Yes	85 (47.5%)
	No	94 (52.5%)
Disease Duration (Days)	7 Or Below	48 (26.8%)
	More Than 7	131 (73.2%)
Department	IPD	90 (50.3%)
	OPD	89 (49.7%)

The most common pathogen was E coli, recorded in 48 patients (26.8%), and the least common isolated pathogen was S aureus (n=9, 5.0%) (Table 2).

Table 2: Various Pathogens Isolated in the Study Cohort (n=179)

Pathogens	Frequency (%)
E coli	48 (26.8%)
Proteus	33 (18.4%)
Pseudomonas	34 (19.0%)
Klebsiella	30 (16.8%)
Strep	15 (8.4%)
Enterococci	10 (5.6%)
Staph	9 (5.0%)

Isolates in 154 (86.0%) out of 179 participants were susceptible to nitrofurantoin followed by meropenem in 151 (84.3%), ceftriaxone (69.2%) and amikacin in 116 (64.8%) respectively (Table 3).

Table 3: Susceptibility Pattern of Pathogens to Various Antibiotics (n=179)

Antibiotics		Pathogens							Total
		E coli	Proteus	Pseudomonas	Klebsiella	Strep	Enterococci	Staph	
Ampicillin	S	28 (29.8%)	16 (17.0%)	23 (24.5%)	11 (11.7%)	8 (8.5%)	5 (5.3%)	3 (3.2%)	94 (100.0%)
	R	20 (23.5%)	17 (20.0%)	11 (12.9%)	19 (22.4%)	7 (8.2%)	5 (5.9%)	6 (7.1%)	85 (100.0%)
Amikacin	S	29 (25.0%)	24 (20.7%)	26 (22.4%)	21 (18.1%)	6 (5.2%)	4 (3.4%)	6 (5.2%)	116 (100.0%)
	R	19 (30.2%)	9 (14.3%)	8 (12.7%)	9 (14.3%)	9 (14.3%)	6 (9.5%)	3 (4.8%)	63 (100.0%)
Ceftriaxone	S	35 (28.2%)	22 (17.7%)	24 (19.4%)	21 (16.9%)	10 (8.1%)	5 (4.0%)	7 (5.6%)	124 (100.0%)
	R	13 (23.6%)	11 (20.0%)	10 (18.2%)	9 (16.4%)	5 (9.1%)	5 (9.1%)	2 (3.6%)	55 (100.0%)
Cefixime	S	26 (23.4%)	24 (21.6%)	21 (18.9%)	21 (18.9%)	9 (8.1%)	5 (4.5%)	5 (4.5%)	111 (100.0%)
	R	22 (32.4%)	9 (13.2%)	13 (19.1%)	9 (13.2%)	6 (8.8%)	5 (7.4%)	4 (5.9%)	68 (100.0%)
Cotrimoxazole	S	26 (31.7%)	9 (11.0%)	17 (20.7%)	14 (17.1%)	8 (9.8%)	6 (7.3%)	2 (2.4%)	82 (100.0%)
	R	22 (22.7%)	24 (24.7%)	17 (17.5%)	16 (16.5%)	7 (7.2%)	4 (4.1%)	7 (7.2%)	97 (100.0%)
Clindamycin	S	25 (27.2%)	22 (23.9%)	12 (913.0%)	15 (16.3%)	8 (8.7%)	6 (6.5%)	4 (4.3%)	92 (100.0%)
	R	23 (26.4%)	11 (12.6%)	22 (25.3%)	15 (17.2%)	7 (8.0%)	4 (4.6%)	5 (5.7%)	87 (100.0%)
Cloxacillin	S	29 (24.8%)	26 (22.2%)	18 (15.4%)	20 (17.1%)	12 (10.3%)	6 (5.1%)	6 (5.1%)	117 (100.0%)
	R	19 (30.6%)	7 (11.3%)	16 (25.8%)	10 (16.1%)	3 (4.8%)	4 (6.5%)	3 (4.8%)	62 (100.0%)
Erythromycin	S	24 (23.8%)	22 (21.8%)	17 (16.8%)	17 (16.8%)	10 (9.9%)	7 (6.9%)	4 (4.0%)	101 (100.0%)
	R	24 (30.8%)	11 (14.1%)	17 (21.8%)	13 (16.7%)	5 (6.4%)	3 (3.8%)	5 (6.4%)	78 (100.0%)
Meropenem	S	39 (25.8%)	28 (18.5%)	30 (19.9%)	26 (17.2%	14 (9.3%)	7 (4.6%)	7 (4.6%)	151 (100.0%)
	R	9 (32.1%)	5 (17.9%)	4 (14.3%)	4 (14.3%)	1 (3.6%)	3 (10.7%)	2 (7.1%)	28 (100.0%)
Ofloxacin	S	28 (26.9%)	15 (14.4%)	23 (22.1%)	20 (19.2%)	10 (9.6%)	4 (3.8%)	4 (3.8%)	104 (100.0%)
	R	20 (26.7%)	18 (24.0%)	11 (14.7%)	10 (13.3%)	5 (6.7%)	6 (8.0%)	5 (6.7%)	75 (100.0%)
Ciprofloxacin	S	25 (30.5%)	10 (12.2%)	15 (18.3%)	16 (19.5%)	7 (8.5%)	6 (7.3%)	3 (3.7%)	82 (100.0%)
	R	23 (23.7%)	23 (23.7%)	19 (19.6%)	14 (14.4%)	8 (8.2%)	4 (4.1%)	6 (6.2%)	97 (100.0%)
Nitrofurantoin	S	40 (26.0%)	28 (18.2%)	28 (18.2%)	28 (18.2%)	15 (9.7%)	7 (4.5%)	8 (5.2%)	154 (100.0%)
	R	8 (32.0%)	5 (20.0%)	6 (24.0%)	2 (8.0%)	0 (0.0%)	3 (12.0%)	1 (4.0%)	25 (100.0%)

S=sensitive, R=resistant

No statistically significant association was observed between pathogens and baseline parameters (p>0.05) (Table 4).

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Table 4: Stratification of Pathogens with Various Clinic-Demographic Parameters (n=179)

Variables		Pathogens							Total	p-value
		E coli	Proteus	Pseudomonas	Klebsiella	Strep	Enterococci	Staph		
Age (Years)	≤50	20 (23.0%)	18 (20.7%)	16 (18.4%)	17 (19.5%)	7 (8.0%)	3 (3.4%)	6 (6.9%)	87 (100.0%)	0.571
	>50	28 (30.4%)	15 (16.3%)	18 (19.6%)	13 (14.1%)	8 (8.7%)	7 (7.6%)	3 (3.3%)	92 (100.0%)	
BMI (kg/m^2)	≤24.0	28 (27.7%)	19 (18.8%)	20 (19.8%)	15 (14.9%)	9 (8.9%)	7 (6.9%)	3 (3.0%)	101 (100.0%)	0.750
	>24.0	20 (25.6%)	14 (17.9%)	14 (17.9%)	15 (19.2%)	6 (7.7%)	3 (3.8%)	6 (7.7%)	78 (100.0%)	
Gender	M	30 (27.5%)	19 (17.4%)	22 (20.2%)	20 (18.3%)	8 (7.3%)	7 (6.4%)	3 (2.8%)	109 (100.0%)	0.621
	F	18 (25.7%)	14 (20.0%)	12 (17.1%)	10 (14.3%)	7 (10.0%)	3 (4.3%)	6 (8.6%)	70 (100.0%)	
DM	Yes	24 (28.2%)	11 (12.9%)	17 (20.0%)	15 (17.6%)	6 (7.1%)	7 (8.2%)	5 (5.9%)	85 (100.0%)	0.477
	NO	24 (25.5%)	22 (23.4%)	17 (18.1%)	15 (16.0%)	9 (9.6%)	3 (3.2%)	4 (4.3%)	94 (100.0%)	
Complaint Duration (Days)	Yes	11 (22.9%)	11 (22.9%)	11 (22.9%)	8 (16.7%)	6 (12.5%)	1 (2.1%)	0 (0.0%)	48 (100.0%)	0.262
	NO	37 (28.2%)	22 (16.8%)	23 (17.6%)	22 (16.8%)	9 (6.9%)	9 (6.9%)	9 (6.9%)	131 (100.0%)	
Department	IPD	25 (27.8%)	18 (20.0%)	16 (17.8%)	13 (14.4%)	9 (10.0%)	6 (6.7%)	3 (3.3%)	90 (100.0%)	0.809
	OPD	23 (25.8%)	15 (16.9%)	18 (20.2%)	17 (19.1%)	6 (6.7%)	4 (4.5%)	6 (6.7%)	89 (100.0%)	

DISCUSSION

The mean age of the participants was 49.93 ± 16.03 years. The majority of study participants were aged more than 50 years (n=92, 51.4%). 109 patients (60.9%) were male, and 85 patients (47.5%) were diabetic. 89 patients (49.7%) were enrolled from the Outpatient Department. The most common pathogen was E coli, recorded in 48 patients (26.8%), and the least common isolated pathogen was S aureus (n=9, 5.0%). Nitrofurantoin was the most effective. Isolates in 154 (86.0%) out of 179 participants were susceptible to nitrofurantoin, followed by meropenem in 151 (84.3%), ceftriaxone (69.2%) and amikacin in 116 64.8%), respectively. The majority of isolates in this study were obtained from male patients. Isolation rate concerning gender was statistically insignificant in a study by Patel *et al.*, which was in contrast to our findings [12]. A higher proportion of female patients was reported in other studies, including George *et al.*, and Singhal *et al.*, [13, 14]. Our study results are, however, similar to those reported by Mehboob *et al.*, where 57.0% of the study cohort comprised male patients [15].This difference in the results may be explained by the fact that female patients tend to seek treatment at the loco-regional level and seldom report to tertiary care centers like ours due to socio-cultural and financial reasons.Moreover, time-consuming tests such as culture are not preferred on the part of the patient, particularly female, owing to the delay in result availability and delayed initiation of treatment.The most common isolate from our study cohort was E coli, followed by Pseudomonas, Proteus and Klebsiella. Staph group and enterococci constituted the least commonly retrieved pathogens. The bacterial spectrum in isolates in Patel *et al.*, in descending order, was E coli, Candida and Klebsiella [12]. Bhargava *et al.*, reported E coli as the most common pathogen, followed by Proteus, Klebsiella and Pseudomonas [16].In another study by Al-Awkally *et al.*, E coli was the most common causative agent of urinary tract infection in their study participants, and Enterococci and Staphylococcus species were the least prevalent uropathogens [17]. Mehboob *et al.*, and Said *et al.*, reported similar findings concerning the distribution of uropathogens [15, 18].Our results are in agreement with these studies' findings.E coli accounts for more than three-fourths of all urinary tract infections globally and more than 50.0% of complicated infections requiring hospitalization. The higher incidence of E coli-related UTIs may be because of the increased pathogenicity of E coli and increased susceptibility of urinary tract mucosa towards invasion by E coli [19]. Nitrofurantoin was the most effective antibiotic against uropathogens isolated from our study participants, followed by meropenem and third-generation cephalosporins.The least susceptibility was observed towards older antibiotics such as ampicillin.Ciprofloxacin susceptibility was disappointing. Girma *et al.*, reported nitrofurantoin as the most effective antibiotic in urinary tract infections in their study. Ceftriaxone and norfloxacin were shown to have adequate sensitivity [20].Lowest resistance to nitrofurantoin and ceftriaxone was reported in a study by Majumder *et al.*, [21]. In studies by Patel *et al.*, AND Adugna N *et al.*, 100% susceptibility was observed with meropenem [12, 22].Nitrofurantoin was shown to be slightly inferior to meropenem in a study by Bhargava *et al.*, [16].In a study by Madeeha *et al*, nitrofurantoin and meropenem were the most effective antibiotics against uropathogens obtained in the culture isolate [15]. Ciprofloxacin though routinely and most often empirically prescribed in urinary tract infections, but resistance is now increasingly reported, as evident from this study and the results of the study by Said *et al.*, [18]. Increased resistance to ciprofloxacin was reported by Girma A *et al.*, urinary tract infections [20].Fluoroquinolones like ciprofloxacin, once effective in UTI, have had their efficacy reduced over the years.It may be because of the rampant and empirical administration of ciprofloxacin in various infections. Overall, the study provided valuable insights into microbial

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trends and sensitivity patterns in patients with urinary tract infections.

CONCLUSIONS

It was concluded that people of all ages can be affected by urinary tract infection; however, elderly male patients are more frequently affected. The most common pathogen leading to urinary tract infection isolated in culture is E. coli. Currently, nitrofurantoin and meropenem are the most effective antibiotics against uropathogens. Sensitivity pattern of antibiotics and pathogen distribution is not affected by patient baseline clinic-demographic parameters.

Authors Contribution

Conceptualization: MZ

Methodology: MZ, SA, FA, RG

Formal analysis: MZ

Writing review and editing: MZ, SA, NI, FA, SN

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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