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Types of Uropathogens and Pattern of Antimicrobial Resistance among Urinary Tract Infected Patients Presenting to Primary Care

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ABSTRACT

Urinary Tract Infections (UTIs) were prevalent bacterial infections with significant public health impacts, particularly affecting females due to anatomical predispositions. **Objective:** To assess the types of uropathogens and their antimicrobial resistance profiles among patients with UTIs presenting to a private clinic in districts Dir Lower and Upper, Pakistan. **Methods:** A prospective observational study was conducted, enrolling 109 patients with symptoms suggestive of UTIs. Urine samples were collected and subjected to culture and sensitivity testing. Data on patient demographics, uropathogen identification, and antibiotic susceptibility patterns were analyzed using SPSS version 21.0. **Results:** *Escherichia coli* was the predominant uropathogen, isolated in 51.90% of patients, followed by *Pseudomonas aeruginosa* (12.00%), *Enterococcus* (9.80%), *Staphylococcus aureus* (3.80%), and *Serratia odorifera* (1.50%). Among *Escherichia coli* isolates, Nitrofurantoin exhibited the highest sensitivity (91.30%), while Ampicillin, Cefixime, Amoxicillin, and Ceftriaxone showed substantial resistance rates (>85%). *Pseudomonas aeruginosa* demonstrated high resistance to all tested antibiotics. *Enterococcus* and *Staphylococcus aureus* exhibited variable sensitivity patterns, while *Serratia odorifera* displayed uniform sensitivity to the antibiotics tested. **Conclusions:** *Escherichia coli* was the predominant uropathogen isolated among patients with UTIs in districts Dir Lower and Upper, Pakistan, with varying susceptibility patterns to commonly prescribed antibiotics.

INTRODUCTION

Urinary Tract Infections (UTIs) are among the most prevalent bacterial infections globally, affecting individuals across diverse demographics and healthcare settings. These infections encompass a spectrum of clinical manifestations, ranging from asymptomatic bacteriuria to severe kidney infections culminating in sepsis [1]. UTI is characterized as urethritis (urethral infection), cystitis (bladder inflammation), or pyelonephritis (kidney infection), or it can progress to a bloodstream infection, resulting in urosepsis [2]. Uncomplicated UTIs (cystitis and pyelonephritis) affect healthy individuals in the absence of anatomical or neurological urinary tract problems. Complicated UTIs are associated with conditions that limit urinary tract or host defense, such as urinary obstruction, urine retention, immunosuppression, renal failure, pregnancy, and indwelling catheters or other drainage device [3]. The intestinal flora was the primary source of uropathogens that cause UTIs, which supports the reasoning for empirical treatment approaches for CA-UTIs (community-acquired UTIs) [4]. Uropathogenic Escherichia coli (UPECs), the primary etiological agent of UTIs, account for approximately 75% of all cases [5]. Although empirical treatments are useful, they pose limitations by impeding the monitoring of antibiotic responses and fostering antibiotic resistance among UTI-causing pathogens [4]. In recent years, the alarming rise in

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Antimicrobial Resistance (AMR) among uropathogens has emerged as a pressing global concern [6]. This phenomenon poses a grave threat to public health, with over 700,000 deaths attributed to AMR-related complications each year worldwide [7]. If left unchecked, projections indicate that by 2050, AMR could claim the lives of over 10 million individuals annually and impose substantial economic burdens [7]. Importantly, this crisis transcends national boundaries, impacting countries irrespective of income levels or developmental statuses. Of particular concern are regions such as Africa and South-East Asia, where the lack of established AMR surveillance systems exacerbates the challenge [8]. In 2014, the World Health Organization (WHO) highlighted the absence of such systems in these regions. Within Pakistan, studies have underscored the severity of AMR, revealing resistance rates of 83% to four antibiotics and 65.5% to more than eight antibiotics [9, 10]. Although UTI is treatable, multidrug-resistant strains lead to treatment failure and complications, resulting in significant morbidity and mortality in hospitals [11].

In light of these challenges, this study endeavors to elucidate the landscape of common uropathogens and their antimicrobial resistance profiles, aiming to establish a localized antibiogram. By shedding light on the prevailing resistance patterns, this research seeks to inform clinical decision-making, mitigate morbidity associated with UTIs, foster community awareness regarding culture and sensitivity testing, and guide the judicious prescription of antimicrobial agents, contributing to the global efforts to combat antimicrobial resistance.

METHODS

This prospective observational study investigated UTIs among patients presenting with symptoms such as frequency, urgency, painful urination, flank pain, and fever. Conducted during November 1st 2022 to October 31st 2023 at the medical outpatient department of DHQ Timergara Medical College Teaching Hospital, the study aimed to provide insights into patient demographics, urinary pathogens, and antibiotic resistance patterns.

A total of 109 patients were enrolled in the study. The sample size was determined based on convenience sampling of eligible patients presenting during the study period, rather than through prior power calculations. This approach was adopted due to practical constraints, including time and resource availability. All patients with white cells in urine at a count of ≥ 8-10 per high power field and who had not used antibiotics for at least 72 hours prior to presentation were included in the study. While those who had taken antibiotics within the last 72 hours were kept under the exclusion criteria.

Data collection involved clinical examinations and laboratory investigations, with patient samples cultured and tested for sensitivity using standard protocols. Urinary pathogens and their antibiotic susceptibility profiles were identified through established microbiological techniques. Standardized procedures for urine culture and sensitivity testing were employed to ensure accuracy and consistency of results. Quantitative variables assessed the number of white cells in urine per high-power field, bacterial colony counts on culture, and antibiotic susceptibility/resistance patterns of identified pathogens. Cultures were performed using media such as McConkey agar and cystine lactose electrolyte deficient medium. Data were analyzed using SPSS version 21.0, with descriptive statistics summarizing patient demographics and characteristics of urinary pathogens. Frequency distributions and percentages were calculated for qualitative variables, while means and standard deviations were used for quantitative variables. The study was conducted after receiving ethical approval from the institutional ethical review board, Ref# 1070/TMC.CE.2023-24. Written consent was obtained from patients who met the inclusion criteria and demonstrated bacterial growth on urinary culture and sensitivity testing, ensuring they were fully informed about the study.

RESULTS

A total of 109 patients were enrolled in this study, comprising 37.60% males and 44.40% females, with a median age of 50.15 ± 18.42 years. The most prevalent presenting symptoms among the patients were urinary frequency (67.70%) followed by fever (Table 1).

Table 1: Baseline Characteristics of the Patients with Urinary Tract Infection (n=109)

Variables	Mean ± SD/N (%)
Age (Years)	50.15 ± 18.42
Gender	
Male	50 (37.60%)
Female	59 (44.40%)
Urinary Tract Infection Manifestations	
Urgency	81 (60.90%)
Frequency	90 (67.70%)
Flanks pain	47 (35.30%)
Fever	89 (66.90%)
Pathogens	
E. coli	69 (51.90%)
Pseudomonas aeruginosa	16 (12.00%)
Enterococcus	13 (09.80%)
Klebsiela pneumonia	4 (03.00%)
Staphylococcus aureus	5 (03.80%)
Serration ordorifera	2 (01.50%)

The predominant pathogen isolated from the urine cultures was *Escherichia coli*, which was identified in 51.90% of patients. It was followed by *Pseudomonas aeruginosa* in 12.0%, *Enterococcus* in 9.80%, *Staphylococcus aureus* in 3.80%, and *Serratia odorifera* in 1.50% of patients. Among patients infected with *Escherichia coli*, the most sensitive drugs were

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Nitrofurantoin (91.30%), Fosfomycin (98.90%), Meropenem (89.90%), and Piperacillin (87.0%), while the most resistant drugs included Ampicillin (92.80%), Cefixime (88.40%), Amoxicillin (87.0%), and Ceftriaxone (87.0%). *Pseudomonas aeruginosa* exhibited high resistance to all tested drugs, as detailed in table 2. *Enterococcus* demonstrated equal sensitivity patterns, with 92.30% of patients exhibiting sensitivity to Fosfomycin, Nitrofurantoin, Piperacillin, and Meropenem. *Staphylococcus aureus* displayed 80% sensitivity to Nitrofurantoin and Meropenem, while *Serratia odorifera* exhibited 100% sensitivity to Nitrofurantoin, Fosfomycin, Meropenem, and Piperacillin, respectively. *Escherichia coli* was the most commonly isolated pathogen in patients presenting with urinary tract infection. It was highly sensitive to Nitrofurantoin, Fosfomycin, Meropenem, and Piperacillin. Conversely, *Pseudomonas aeruginosa* exhibited resistance to all tested antibiotics. *Enterococcus* and *Staphylococcus aureus* displayed varying sensitivity patterns, with *Serratia odorifera* demonstrating uniformly high sensitivity to the antibiotics tested.

Table 2: Uropathogens Pattern of Sensitivity and Resistance

		Isolates N (%)					
Antibiotics Used	Pattern	*Escherichia coli*	*Pseudomonas aeruginosa*	*Enterococcus*	*Klebsiela pneumonia*	*Staphylococcus aureus*	*Serration ordorifera*
Fosfomycin	S	62 (89.90%)	2 (12.50%)	12 (92.30%)	2 (50.00%)	3 (60.00%)	2 (100.00%)
	R	7 (10.10%)	14 (87.50%)	1 (7.70%)	2 (50.00%)	2 (40.00%)	-
Nitrofurontoin	S	63 (91.30%)	3 (18.80%)	12 (92.30%)	3 (75.00%)	4 (80.00%)	2 (100.00%)
	R	6 (8.70%)	13 (81.20%)	1 (7.70%)	1 (25.00%)	1 (20.00%)	-
Levofloxacin	S	28 (40.60%)	2 (12.5%)	5 (38.50%)	1 (25.00%)	1 (20.00%)	2 (100.00%)
	R	41 (59.40%)	14 (87.50%)	8 (61.50%)	3 (75.00%)	4 (80.00%)	-
Ciprofloxacin	S	26 (37.70%)	1 (6.20%)	4 (30.80%)	1 (25.00%)	1 (20.00%)	2 (100.00%)
	R	43 (62.30%)	15 (93.80%)	9 (69.20%)	3 (75.00%)	4 (80.00%)	-
Ofloxacin	S	28 (40.60%)	1 (6.20%)	5 (38.30%)	1 (25.00%)	1 (20.00%)	2 (100.00%)
	R	41 (59.40%)	15 (93.80%)	8 (61.50%)	3 (75.00%)	4 (80.00%)	-
Amoxicillin	S	9 (13.00%)	2 (12.50%)	8 (61.50%)	2 (50.00%)	2 (40.00%)	2 (100.00%)
	R	60 (87.00%)	14 (87.50%)	5(38.50%)	2 (50.00%)	3 (60.00%)	-
Ampicillin	S	5 (7.50%)	1 (6.20%)	7 (53.80%)	-	2 (40.00%)	2 (100.00%)
	R	65 (92.80%)	15 (93.80%)	6 (46.20%)	4 (100.00%)	3 (60.00%)	-
Cefixime	S	8 (11.60%)	2 (12.50%)	7 (53.80%)	1 (25.00%)	2 (40.00%)	2 (100.00%)
	R	61 (88.40%)	14 (87.50%)	6 (46.20%)	3 (75.00%)	3 (60.00%)	-
Ceftriaxone	S	9 (13.00%)	2 (12.50%)	6 (46.20%)	1 (25.00%)	2 (40.00%)	2 (100.00%)
	R	60 (87.00%)	14 (87.50%)	7 (53.80%)	3 (75.00%)	3 (60.00%)	-
Piperacillin	S	60 (87.00)	4 (25.00)	12 (92.30)	3 (75.00)	3 (60.00)	2 (100.005)
	R	9 (13.00%)	12 (75.00%)	1 (7.70%)	1 (25.00%)	2 (40.00%)	-
Meropenem	S	62 (89.90%)	4 (25.00)	12 (92.30%)	3 (75.00%)	4 (80.00%)	2 (100.00%)
	R	7 (10.10%)	12 (75.00%)	1 (7.70%)	1 (25.00%)	1 (20.00%)	-
Doxycycline	S	32 (46.40%)	3 (18.80%)	3 (23.10%)	1 (25.00%)	3 (60.00%)	-
	R	37 (53.60%)	13 (81.20%)	10 (76.90%)	3 (75.00%)	3 (60.00%)	-
Co-trimoxazole	S	20 (29.00%)	3 (18.80%)	3 (23.10%)	1 (25.00%)	3 (60.00%)	-
	R	49 (71.00%)	13 (81.20%)	10 (76.90%)	3 (75.00%)	2 (40.00%)	2 (100.00%)

S-Sensitive; R-Resistance

DISCUSSION

This study aimed to determine the prevailing uropathogens in the population of districts Dir Lower and Upper, Pakistan, along with their antimicrobial sensitivity and resistance patterns, with the ultimate objective of establishing a localized antibiogram. These findings underscore the common occurrence of UTIs and highlight concerning trends in resistance to commonly utilized antibiotics. *Escherichia coli* emerged as the predominant pathogen in this study. Consistency in the prevalence of *Escherichia coli* as the primary uropathogen was noted across various geographical locations. Studies conducted by Haindongo EH *et al.*, in Namibia, Abongomera G et al., in Uganda, and Tanvir R *et al.*, in Lahore, Pakistan, reported similar findings, with prevalence rates ranging from 40.70% to 73.1% [12, 13, 10]. Furthermore, these findings align with those of Adugna B *et al.*, where *Escherichia coli* emerged as the most predominant bacterium isolated from urine, followed by *Enterobacter spp.*, *Enterococcus spp.*, and *Klebsiella spp.* Similar trends were observed in other studies as well, further supporting the consistency and

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reliability of this findings [6, 14-16]. Additionally, this study's observation of a predominance of Gram-negative organisms (80.9%) aligns closely with comparable research (81.3%) [17]. Firissa YB *et al.*, found that gram-negative bacteria accounted for 84% of the isolates, with gram-positive bacteria comprising the remaining 16% [18]. These results were consistent with findings reported by Tiruneh M *et al.*, and Kasew D *et al.*, from Gondar, Ethiopia, as well as other studies conducted elsewhere [15, 19]. Nitrofurantoin showed the highest sensitivity rate of 91.30% of the tested antibiotics against *Escherichia coli*, closely followed by Fosfomycin (89.90%) and Meropenem (89.90%). On the other hand, resistance rates to ampicillin, cefixime, amoxicillin, and ceftriaxone were much higher than 85%. The results of this investigation suggest high sensitivity of Nitrofurantoin (91.30%) against *Escherichia coli*, aligning with empirical treatment guidelines, which may warrant consideration as a first-line oral therapy. However, disparities were noted in the sensitivity rates of injectable antibiotics such as Meropenem and Piperacillin, which were lower than previously reported figures. Fosfomycin, particularly in single-dose preparations, demonstrated promising sensitivity rates (89.90%), consistent with previous study highlighting its efficacy against Gram-negative microorganisms [20]. Conversely, quinolones, including levofloxacin, ciprofloxacin, and ofloxacin, exhibited significant resistance rates exceeding 55%, reflecting trends observed in developing countries. In a study by Firissa YB *et al.*, *Enterococcus spp.*, *Enterobacter spp.*, and *Klebsiella spp.* were found to be resistant to Ceftriaxone, Ceftazidime, Ciprofloxacin, Cotrimoxazole, Gentamicin, and Nalidixic Acid but sensitive to Nitrofurantoin, Vancomycin, and Cefoxitin [18]. Of significant concern was the escalating resistance observed among cephalosporins, namely ceftriaxone, cefixime, amoxicillin, and ampicillin, with resistance rates surpassing 85%. This stark contrast with previously reported figures (33.9% and 22%) underscores the urgent need for interventions to curb the indiscriminate use of these antimicrobial agents, often exacerbated by self-medication practices within the local community [12, 21]. However, it was imperative to acknowledge the limitations inherent in this study. Although the data were primarily collected from a single private clinic in districts Dir Lower and Upper, Pakistan, expanding the data collection to multiple setups could have provided a more representative sample of the entire population. Additionally, extending the duration of the study could improve the sample size, thereby enhancing the reliability of the results. Moreover, the exclusion criteria of patients who had received antibiotics within 72 hours prior to urine sample collection might have led to the underrepresentation of certain patient groups, potentially affecting the generalizability of the findings. Furthermore, the study did not assess factors such as comorbidities or previous UTI episodes, which could influence both the prevalence of uropathogens and their antimicrobial resistance patterns.

CONCLUSIONS

The observation of Antimicrobial Resistance (AMR), particularly with cephalosporins, suggests a need for further investigations into initiatives aimed at curbing indiscriminate antimicrobial use. Against Escherichia coli, Nitrofurantoin, fosfomycin, meropenem, and piperacillin have shown significant sensitivity, suggesting their potential as empirical therapy alternatives pending confirmation in larger studies. The study highlighted the significance of current empirical management strategies and initiatives to combat AMR nationally and internationally.

Authors Contribution

Conceptualization: SB, FU

Methodology: AR[1]

Formal analysis: AG

Writing, review and editing: AR[2], HUR, AG

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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REFERENCES

[1] Sabih A, Leslie SW. Complicated urinary tract infections. Treasure Island (FL). In: StatPearls Publishing. [Last cited: 12th Nov 2023]. Available at: https://www.ncbi.nlm.nih.gov/books/NBK436013/.

[2] Paul D, Anto N, Bhardwaj M, Prendiville A, Elangovan R, Bachmann TT *et al*. Antimicrobial Resistance in Patients with Suspected Urinary Tract Infections in Primary Care in Assam, India. JAC-Antimicrobial Resistance. 2021 Dec;3(4):17.doi:10.1093/jacamr/dlab164.

[3] Bruxvoort KJ, Bider-Canfield Z, Casey JA, Qian L, Pressman A, Liang AS *et al*. Outpatient Urinary Tract Infections in an Era of Virtual Healthcare: Trends From 2008 To 2017. Clinical Infectious Diseases. 2020 Jun; 71(1): 100-8.doi: 10.1093/cid/ciz764.

[4] Yamin D, Uskoković V, Wakil AM, Goni MD, Shamsuddin SH, Mustafa FH *et al*. Current and future technologies for the detection of antibiotic-resistant bacteria. Diagnostics.2023Oct;13(20):3246.doi:10.3390/diagnostics13203246.

DOI: https://doi.org/10.54393/pjhs.v5i09.1757

[5] Zagaglia C, Ammendolia MG, Maurizi L, Nicoletti M, Longhi C. Urinary Tract Infections Caused by Uropathogenic Escherichia Coli Strains—New Strategies for an Old Pathogen. Microorganisms. 2022 Jul; 10(7): 2-12.doi:10.3390/microorganisms10071425.
[6] Schito GC, Naber KG, Botto H, Palou J, Mazzei T, Gualco L *et al.* The ARESC study: an international survey on the antimicrobial resistance of pathogens involved in uncomplicated urinary tract infections. International Journal of Antimicrobial Agents. 2009 Nov; 34(5): 407-13.doi:10.1016/j.ijantimicag.2009.04.012.
[7] Tuem KB, Desta R, Bitew H, Ibrahim S, Hishe HZ. Antimicrobial resistance patterns of uropathogens isolated between 2012 and 2017 from a tertiary hospital in Northern Ethiopia. Journal of Global Antimicrobial Resistance. 2019 Sep; 18: 109-14. doi: 10.1016/j.jgar.2019.01.022.
[8] World Health Organization. Antimicrobial resistance: global report on surveillance. World Health Organization; 2014.
[9] Ullah F, Malik S, Ahmed J. Antibiotic susceptibility pattern and ESBL prevalence in nosocomial Escherichia coli from urinary tract infections in Pakistan. African Journal of Biotechnology. 2009; 8(16).
[10] Tanvir R, Hafeez R, Hasnain S. Prevalence of multiple drug resistant Escherichia coli in patients of urinary tract infection registering at a diagnostic laboratory in Lahore Pakistan. Pakistan Journal of Zoology. 2012 May; 44(3): 707-12.
[11] Arif H, Mehmood S, Ali A, Khan MA, Ahmed SN, Farooq L. In Vitro Activity of Ceftolozane/Tazobactam for The Treatment of Complicated Urinary Tract Infections by Escherichia Coli in the Era of Antibiotic Resistance "Rejuvenate The Mystery". Journal of Pharmaceutical Research International. 2019 Oct; 30(3): 1-7. doi: 10.9734/jpri/2019/v30i330270.
[12] Haindongo EH, Funtua B, Singu B, Hedimbi M, Kalemeera F, Hamman J *et al.* Antimicrobial resistance among bacteria isolated from urinary tract infections in females in Namibia, 2016-2017. Antimicrobial Resistance & Infection Control. 2022 Feb; 11(1): 33. doi: 10.1186/s13756-022-01066-2.
[13] Abongomera G, Koller M, Musaazi J, Lamorde M, Kaelin M, Tasimwa HB *et al.* Spectrum of antibiotic resistance in UTI caused by Escherichia coli among HIV-infected patients in Uganda: a cross-sectional study. BioMed Central Infectious Diseases. 2021 Dec; 21: 1-7. doi: 10.1186/s12879-021-06865-3.
[14] Adugna B, Sharew B, Jemal M. Bacterial Profile, Antimicrobial Susceptibility Pattern, and Associated Factors of Community-and Hospital-Acquired Urinary Tract Infection at Dessie Referral Hospital, Dessie, Northeast Ethiopia. International Journal of Microbiology. 2021 Sep; 2021(1): 5553356. doi: 10.1155/2021/5553356.
[15] Tiruneh M, Yifru S, Gizachew M, Molla K, Belyhun Y, Moges F *et al.* Changing trends in prevalence and antibiotics resistance of uropathogens in patients attending the Gondar University Hospital, Northwest Ethiopia. International Journal of Bacteriology. 2014; 2014(1): 629424. doi: 10.1155/2014/629424.
[16] Beyene G and Tsegaye W. Bacterial uropathogens in urinary tract infection and antibiotic susceptibility pattern in Jimma University specialized hospital, southwest ethiopia. Ethiopian Journal of Health Sciences. 2011 Jul; 21(2): 141-6. doi:10.4314/ejhs.v21i2.69055.
[17] Mohammed MA, Alnour TM, Shakurfo OM, Aburass MM. Prevalence and antimicrobial resistance pattern of bacterial strains isolated from patients with urinary tract infection in Messalata Central Hospital, Libya. Asian Pacific Journal of Tropical Medicine. 2016 Aug; 9(8): 771-6. doi: 10.1016/j.apjtm.2016.06.011.
[18] Firissa YB, Shelton D, Azazh A, Engida H, Kifle F, Debebe F. Prevalence and antimicrobial sensitivity patterns of uropathogens, in tikur anbessa specialized hospital emergency medicine department Addis Ababa, Ethiopia. Infection and Drug Resistance. 2023 Dec: 1649-56. doi: 10.2147/IDR.S402472.
[19] Kasew D, Desalegn B, Aynalem M, Tila S, Diriba D, Afework B *et al.* Antimicrobial resistance trend of bacterial uropathogens at the university of Gondar comprehensive specialized hospital, northwest Ethiopia: A 10 year's retrospective study. PLOS One. 2022 Apr; 17(4): e0266878. doi:10.1371/journal.pone.0266878.
[20] Minassian MA, Lewis DA, Chattopadhyay D, Bovill B, Duckworth GJ, Williams JD. A comparison between single-dose fosfomycin trometamol (Monuril®) and a 5-day course of trimethoprim in the treatment of uncomplicated lower urinary tract infection in women. International Journal of Antimicrobial Agents. 1998 Apr; 10(1): 39-47. doi: 10.1016/S0924-8579(98)00021-1.
[21] Shimoni Z, Salah M, Kasem A, Hermush V, Froom P. Bacterial Resistance to Cephalosporin Treatment in Elderly Stable Patients Hospitalized With a Urinary Tract Infection. The American Journal of the Medical Sciences. 2020 Sep; 360(3):2437.doi:10.1016/j.amjms.2020.05.008.