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Original Article

Clinical Profile, Microbiological Spectrum, And Antibiotic Resistance Patterns of Complicated Urinary Tract Infections at A Tertiary Care Hospital.

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ABSTRACT

Background: Complicated urinary tract infections (cUTIs) are associated with significant morbidity, prolonged hospitalization, and increased healthcare costs, particularly among patients with underlying urological abnormalities and comorbidities. The growing prevalence of antimicrobial-resistant uropathogens has reduced the effectiveness of empirical antibiotic therapy, emphasizing the importance of understanding local microbiological patterns and resistance profiles to guide appropriate treatment and antimicrobial stewardship.

Objective: To determine the clinical profile, microbiological spectrum, antimicrobial resistance patterns, and associated factors of multidrug-resistant organisms among hospitalized adult patients with complicated urinary tract infections.

Methods: This cross-sectional observational study was conducted in the Department of Nephrology, Prime Teaching Hospital, Peshawar, Pakistan, from January to June 2025. We enrolled 100 adult patients with clinically diagnosed complicated urinary tract infections through consecutive non-probability sampling. We recorded clinical characteristics, associated risk factors, urine culture findings, isolated microorganisms, and antimicrobial susceptibility patterns using a structured proforma. Antibiotic susceptibility testing was performed according to Clinical and Laboratory Standards Institute (CLSI) recommendations. Data were analyzed using SPSS version 27.0. Continuous variables were expressed as mean ± standard deviation, categorical variables as frequencies and percentages, and p-values <0.05 were considered statistically significant.

Results: The mean age of participants was 54.8 ± 15.2 years, and 58% were male. Diabetes mellitus (46%), urinary tract obstruction (31%), indwelling urinary catheterization (28%), and nephrolithiasis (24%) were the predominant risk factors. Fever (78%), dysuria (69%), flank pain (57%), and urinary frequency (52%) were the most common presenting symptoms. Urine cultures were positive in 91% of patients. Escherichia coli was the predominant pathogen, accounting for 51 (56.0%) of the 91 culture-positive isolates, followed by Klebsiella pneumoniae (19.8%), Pseudomonas aeruginosa (11.0%), and Enterococcus faecalis (6.6%). High resistance was observed to ampicillin (82%), ciprofloxacin (68%), and ceftriaxone (61%), whereas meropenem (9%), amikacin (18%), and nitrofurantoin (22%) showed comparatively lower resistance. Multidrug-resistant organisms were identified in 39 of 91 culture-positive isolates (42.9%) and were significantly associated with diabetes mellitus (p=0.018), indwelling urinary catheterization (p=0.031), and urinary tract obstruction (p<0.001).

Conclusion: Escherichia coli was the predominant pathogen causing complicated urinary tract infections, with high antimicrobial resistance to commonly prescribed empirical antibiotics. Routine urine culture, antimicrobial susceptibility testing, and continuous surveillance of local resistance patterns are essential to optimize empirical therapy, strengthen antimicrobial stewardship, and improve patient outcomes.

INTRODUCTION

Complicated urinary tract infections (cUTIs) are a major problem in worldwide healthcare and are one of the most prevalent bacterial hospital-acquired infections. cUTI refers to a UTI among people who have an anatomical or functional abnormality of the urinary tract or to those who have other medical conditions that place them at risk for failure to treat the UTI or for having frequent UTIs or developing severe UTI complications. Predisposing factors include urinary tract obstruction, nephrolithiasis, urinary tract surgical interventions, neurogenic bladder, diabetes mellitus, chronic kidney disease, immunosuppression, and indwelling urinary catheters. Infections are linked to increased morbidity, hospitalization time, healthcare costs and, in more severe cases, urosepsis and death [1,2]. The global challenge of antimicrobial resistance has added to the complexity of cUTI management. Many first-line antibiotics have become less effective because of the prevalence of extended-spectrum β-lactamase (ESBL)-producing and multidrug-resistant (MDR) organisms, necessitating empirical antibiotic therapy before urine culture results are known. The number of organisms resistant to fluoroquinolones, third-generation cephalosporins, and aminopenicillins has risen significantly over the last 10 years, affecting management options and increasing the need for culture-based therapy. Inappropriate use of empirical antibiotics leads to treatment failure, increases the risk of recurrence, and perpetuates resistance [3,4]. The microbiological profile of complicated urinary tract infections varies according to geographic region, healthcare setting, patient characteristics, and local antimicrobial prescribing practices. E. coli is the most common pathogen that causes UTI, followed by Klebsiella pneumoniae, Pseudomonas aeruginosa, and Proteus mirabilis, Enterococcus faecalis, and Gram-negative bacilli. Patients who are hospitalized or have an indwelling urinary device are especially vulnerable to infection with resistant organisms such as MDR and CRE. Therefore, monitoring the local microbiological spectrum is crucial to inform evidence-based empirical therapy and infection-prevention strategies [5,6]. Several patient-related and Healthcare-associated factors significantly increase the likelihood of multidrug-resistant uropathogen infection. Diabetes mellitus also affects immune function and increases the risk of recurrent UTIs, and urinary tract obstruction and nephrolithiasis increase the likelihood of bacterial persistence and biofilm formation. Likewise, prolonged catheterization creates a breeding ground for bacterial colonization, which greatly increases the risk of catheter-associated urinary tract infections. Identification of these risk factors allows doctors to identify those more likely to develop resistant infections and manage treatment optimally early [7,8]. Urine culture and antimicrobial susceptibility testing remain the gold standard for diagnosing cUTIs and choosing antibiotic treatment. Ideally, urine cultures should be obtained before initiating antimicrobial therapy, in accordance with international guidelines. However, empirical antibiotic use remains common in routine clinical cases because of the need for rapid treatment and the slow turnaround time of microbiological results. Thus, up-to-date local antibiograms are essential to guide hospital antibiotic policies and antimicrobial stewardship programs, optimizing treatment outcomes and reducing the development of antimicrobial resistance [9]. Despite the high burden of complicated urinary tract infections in Pakistan, updated institution-specific data regarding pathogen distribution and antimicrobial resistance remain limited. This lack of local surveillance makes empirical antibiotic selection difficult and may contribute to inappropriate antimicrobial use and increasing multidrug resistance."This study assessed the clinical profile, microbiological spectrum, and antibiotic resistance profile of patients presenting with complicated UTI at a tertiary care hospital. The findings are expected to provide evidence regarding local pathogen distribution and antimicrobial resistance patterns to guide empirical antibiotic therapy and antimicrobial stewardship, with valuable data on pathogen prevalence, regional resistance patterns, and evidence-based antibiotic selection, leading to better patient outcomes and infection control practices.

Study Objectives

The clinical characteristics, microbiological spectrum, and resistance patterns of patients with complicated urinary tract infections, as well as the factors associated with multidrug-resistant bacterial infections, were determined.

MATERIALS AND METHODS

Study Design & Setting

A hospital-based cross-sectional observational study was conducted in the Department of Nephrology, Prime Teaching Hospital, Peshawar, Pakistan, a tertiary-care teaching hospital providing specialized urological services. The study was conducted from 1 January 2025 to 30 June 2025.

Participants

The patient population comprised 100 adults (age ≥ 18 years) diagnosed with complicated urinary tract infection (cUTI) through consecutive non-probability sampling. Patients with clinical signs and symptoms suggestive of cUTI with positive culture or high clinical suspicion in need of hospitalization were enrolled. People with uncomplicated UTIs, those with a pregnancy, or those with incomplete clinical data were not included in the study.

Sample Size Calculation

The sample size was calculated using the WHO Sample Size Calculator, assuming a prevalence of 50%, a 95% confidence level, and a 5% margin of error, given limited regional epidemiological data. The minimum required sample size was 96 participants. To improve precision and allow for potential exclusions, 100 patients were enrolled.

Inclusion Criteria

- Adult patients aged 18 years or older.
- Patients diagnosed with complicated urinary tract infection based on clinical features and laboratory findings.
- Patients requiring hospital admission for management of cUTI.
- Patients with significant bacteriuria on urine culture or strong clinical suspicion of cUTI before culture results.
- Patients who provided written informed consent.

Exclusion Criteria

- Patients with uncomplicated urinary tract infection.
- Pregnant women.
- Patients who had received systemic antibiotics for more than **72 hours** before urine sample collection.
- Patients with contaminated urine specimens or incomplete clinical records.
- Patients who declined to participate in the study.

Diagnostic and Management Strategy

Complicated urinary tract infection was diagnosed according to the European Association of Urology (EAU) guidelines based on compatible clinical features together with laboratory evidence of infection in the presence of structural or functional abnormalities of the urinary tract or associated comorbidities.

Statistical Analysis

Data were entered and analyzed using IBM SPSS Statistics version 27.0. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Associations between categorical variables were evaluated using the Chi-square test or Fisher's exact test, whereas continuous variables were compared using the independent-samples t-test. A p-value <0.05 was considered statistically significant.

Results

We enrolled 100 adult patients with complicated urinary tract infections (cUTIs) during the study period. The mean age was 54.8 ± 15.2 years**,** with 58 (58.0%) males and 42 (42.0%) females**.** The most common predisposing factors were diabetes mellitus (46.0%)**,** followed by urinary tract obstruction (31.0%)**,** indwelling urinary catheterization (28.0%)**,** nephrolithiasis (24.0%)**,** previous history of urinary tract infection (21.0%)**,** and chronic kidney disease (18.0%) (Table 1). The most frequent presenting symptom was **fever (78.0**%), followed by dysuria (69.0%)**,** flank pain (57.0%)**,** urinary frequency (52.0%)**,** costovertebral angle tenderness (**41.0**%), urgency (33**.0**%), nausea/vomiting (29.0%)**,** and hematuria (26.0%) (Table 2). Among the culture-positive isolates, Escherichia coli was the predominant pathogen, accounting for 51 (56.0%) isolates, followed by Klebsiella pneumoniae in 18 (19.8%), Pseudomonas aeruginosa in 10 (11.0%), Enterococcus faecalis in 6 (6.6%), and other organisms in 6 (6.6%) (Table 3). Antimicrobial susceptibility testing showed high resistance to commonly prescribed empirical antibiotics. Resistance was highest for ampicillin (82.0%), followed by ciprofloxacin (68.0%), ceftriaxone (61.0%), trimethoprim-sulfamethoxazole (55.0%), and gentamicin (34.0%). Lower resistance rates were observed for nitrofurantoin (22.0%), amikacin (18.0%), and meropenem (9.0%) (Table 4)**.** Multidrug resistance was defined as acquired non-susceptibility to at least one antimicrobial agent in three or more antimicrobial categories, based on antimicrobial susceptibility testing results. We classified isolates as multidrug-resistant based on their antimicrobial susceptibility profiles**.** MDR infections were significantly associated with diabetes mellitus ($p = 0.018$)**,** indwelling urinary catheterization ($p = 0.031$)**,** and urinary tract obstruction ($p < 0.001$). No statistically significant association was observed with age or gender ($p > 0.05$).

Table 1. demographic and clinical characteristics of hospitalized patients with complicated urinary tract infections. Values are presented as frequency (percentage)

unless otherwise indicated. Continuous variables are expressed as mean ± standard deviation.

Variable	Frequency (n)	Percentage (%)
Age (years), Mean SD	54.8 ± 15.2	—
Gender		
Male	58	58.0
Female	42	42.0
Comorbidities/Risk Factors		
Diabetes mellitus	46	46.0
Urinary tract obstructic	31	31.0
Indwelling urinary catheter	28	28.0
Nephrolithiasis	24	24.0
Chronic kidney diseas	18	18.0
Previous UTI	21	21.0

Values are presented as frequency (percentage) unless otherwise indicated. Continuous variables are expressed as mean ± standard deviation.

Table 2. Clinical Presentation of Hospitalized Patients with Complicated Urinary Tract Infections (N=100)

Clinical Feature	Frequency (n)	Percentage (%)
Fever	78	78.0
Dysuria	69	69.0
Flank pain	57	57.0
Urinary frequency	52	52.0
Hematuria	26	26.0
Urgency	33	33.0
Nausea/Vomiting	29	29.0
Costovertebral angle tenderness	41	41.0

Fever, dysuria, and flank pain were the most common presenting complaints among patients with complicated urinary tract infections.

Table 3. Distribution of Uropathogens Isolated from Culture-Positive Urine Samples (n = 91)

Organism	n	% (n = 91)
Escherichia coli	51	56.0
Klebsiella pneumoniae	18	19.8
Pseudomonas aeruginos	10	11.0
Enterococcus faecalis	6	6.6
Others	6	6.6

Percentages were calculated using the 91 patients with culture-positive complicated urinary tract infections.

Table 4. Antimicrobial Resistance Pattern among Culture-Positive Urine Isolates (n = 91)

Antibiotic	Resistant n (%)
Ampicillin	82 (82.0)
Ciprofloxacin	68 (68.0)
Ceftriaxone	61 (61.0)
Trimethoprim-Sulfamethoxazole	55 (55.0)
Gentamicin	34 (34.0)
Nitrofurantoin	22 (22.0)
Amikacin	18 (18.0)
Meropenem	9 (9.0)

Discussion

The present study evaluated the clinical profile, microbiological spectrum, antimicrobial resistance patterns, and factors associated with multidrug-resistant (MDR) organisms among hospitalized patients with complicated urinary tract infections (cUTIs). The findings demonstrated that Escherichia coli was the predominant uropathogen, followed by Klebsiella pneumoniae, Pseudomonas aeruginosa, and Enterococcus faecalis. A high prevalence of resistance to commonly prescribed empirical antibiotics, particularly ampicillin, ciprofloxacin, and ceftriaxone, was observed, whereas meropenem, amikacin, and nitrofurantoin retained excellent antimicrobial activity. Furthermore, diabetes mellitus, urinary tract obstruction, and indwelling urinary catheterization were significantly associated with MDR infections. These findings emphasize the growing challenge of antimicrobial resistance and reinforce the importance of culture-guided therapy and antimicrobial stewardship in patients with complicated UTIs [10,11]. The demographic profile observed in this study is consistent with previous reports demonstrating that cUTIs predominantly affect older adults with multiple comorbidities. The mean patient age of 54.8 years and the predominance of male patients reflect the higher frequency of urinary tract obstruction, benign prostatic enlargement, catheterization, and other structural urinary abnormalities requiring hospitalization in this population. Similar demographic characteristics have been reported in recent studies from Saudi Arabia, China, and Pakistan, where

hospitalized patients with complicated UTIs were predominantly middle-aged or elderly individuals with underlying medical conditions that increase susceptibility to severe infections [12]. The microbiological findings are comparable to contemporary international literature. Escherichia coli accounted for more than half of all culture-positive isolates, confirming its continued role as the principal causative organism of complicated urinary tract infections despite the increasing prevalence of resistant non-*E. coli* pathogens. Recent multicenter studies have reported comparable proportions of E. coli, while Klebsiella pneumoniae and Pseudomonas aeruginosa remain important hospital-acquired pathogens, particularly among catheterized patients and those with prolonged hospitalization. The relatively high proportion of Pseudomonas isolates observed in the present study may reflect the tertiary-care setting, where patients often have previous antibiotic exposure, urinary instrumentation, or recurrent infections [13,14]. Antimicrobial resistance has emerged as one of the greatest challenges in managing complicated UTIs. The present study demonstrated very high resistance rates to ampicillin, ciprofloxacin, and ceftriaxone, findings that closely resemble those reported in recent studies from South Asia and the Middle East. Increasing resistance to fluoroquinolones and third-generation cephalosporins has been attributed to widespread empirical antibiotic use, inappropriate prescribing practices, and dissemination of extended-spectrum β-lactamase (ESBL)-producing organisms [15,16]. Conversely, meropenem exhibited the lowest resistance rate, while amikacin and nitrofurantoin also maintained favorable susceptibility profiles. These findings support current recommendations to reserve carbapenems for severe infections caused by resistant organisms. In contrast, nitrofurantoin remains an appropriate option for selected lower urinary tract infections when clinically indicated [17]. Preservation of carbapenem efficacy further highlights the importance of antimicrobial stewardship programs aimed at preventing the emergence of carbapenem-resistant Enterobacterales [18]. A noteworthy finding of the present study was the significant association between diabetes mellitus, urinary tract obstruction, indwelling urinary catheterization, and MDR infections. Diabetes predisposes patients to recurrent urinary tract infections through impaired neutrophil function, altered host immunity, glucosuria, and incomplete bladder emptying. Likewise, urinary obstruction promotes urinary stasis and bacterial persistence, while indwelling catheters facilitate biofilm formation and colonization by resistant organisms. Recent studies have consistently reported similar associations, supporting the biological plausibility of these findings. Early identification of patients with these risk factors may facilitate prompt culture-directed therapy, minimize inappropriate empirical antibiotic use, and reduce the risk of treatment failure [19,20]. The clinical implications of this study are particularly relevant for tertiary-care hospitals in Pakistan, where local antibiograms remain limited and empirical antibiotic selection often relies on outdated resistance patterns [21]. Routine urine culture, adherence to Clinical and Laboratory Standards Institute (CLSI) susceptibility testing recommendations, periodic surveillance of local antimicrobial resistance, and implementation of hospital antimicrobial stewardship programs are essential for optimizing empirical treatment protocols.

Limitations

The study was carried out in a single tertiary care hospital, and the sample size was small, limiting the generalizability of the results. Molecular typing of resistant organisms was not performed, nor was the presence of extended-spectrum β-lactamase (ESBL) detected, and there was no long-term follow-up of patients. Larger and multicenter studies are suggested. The cross-sectional design prevented assessment of causal relationships.

Conclusion

Escherichia coli was the predominant uropathogen among hospitalized patients with complicated urinary tract infections, with substantial resistance to commonly used empirical antibiotics. Diabetes mellitus, urinary tract obstruction, and indwelling urinary catheterization were associated with multidrug-resistant infections. Routine urine culture, antimicrobial susceptibility testing, and local resistance surveillance are essential to guide appropriate empirical therapy and strengthen antimicrobial stewardship.

Ethical Approval

Ethical approval was obtained from the Ethical Review Board of Prime Teaching Hospital (approval no: 866/06/24) before commencement of the study. Written informed consent was obtained from all participants before enrollment.

Disclaimer: Nil

Conflict of Interest: Nil

Funding Disclosure: Nil

Authors' Contributions

Concept and Design of Study:Najm Uddin[1], Israr Ahmad Khan[2], Aimal Khan[3]

Data Collection and Data Analysis: Najm Uddin[1], Israr Ahmad Khan[2], Aimal Khan[3]

Drafting of the Manuscript: Najm Uddin[1], Israr Ahmad Khan[2]

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Final Approval of the Version to be Published: All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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