

Clinical and Microbiological Profile of Multidrug-Resistant Urinary Tract Infections in Tertiary Care Hospitals of Punjab

Original Research

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ABSTRACT

BACKGROUND: Urinary tract infections are among the most common bacterial infections encountered in clinical practice. The increasing emergence of multidrug-resistant uropathogens has complicated management, particularly in tertiary care settings where patients often present with recurrent infections, comorbidities, and prior antibiotic exposure. Local data describing both clinical features and resistance patterns remain essential for guiding effective antimicrobial stewardship.

OBJECTIVE: To describe the clinical characteristics and microbiological profile of multidrug-resistant urinary tract infections in tertiary care hospitals of Punjab, Pakistan.

METHODOLOGY: A descriptive observational study was conducted across three tertiary care hospitals in Punjab from March to October 2022. Adult patients with culture-confirmed multidrug-resistant urinary tract infections were included. Clinical data were recorded using a structured proforma, while urine samples underwent standard culture, identification, and antimicrobial susceptibility testing according to established laboratory guidelines. Data were analyzed using appropriate descriptive and inferential statistical tests, with significance set at $p < 0.05$.

RESULTS: A total of 385 patients were analyzed, with a mean age of 46.8 ± 15.2 years; 60.3% were female. Prior antibiotic use was documented in 69.4% of cases, and 44.4% had diabetes mellitus. *Escherichia coli* was the most frequently isolated organism (52.2%), followed by *Klebsiella pneumoniae* (24.9%) and *Pseudomonas aeruginosa* (12.2%). High resistance rates were observed for cephalosporins (78.4%) and fluoroquinolones (74.5%), while lower resistance was noted for carbapenems (15.8%) and nitrofurantoin (22.3%).

CONCLUSION: Multidrug-resistant urinary tract infections are common in tertiary care hospitals of Punjab and are associated with significant resistance to first-line antibiotics. These findings emphasize the need for routine culture-based diagnosis and locally informed antimicrobial stewardship strategies.

KEY TERMS: Antimicrobial Resistance; Carbapenems; Multidrug Resistance; Pakistan; Tertiary Care Hospitals; Urinary Tract Infections; Uropathogens

INTRODUCTION

Urinary tract infections (UTIs) remain among the most frequently encountered bacterial infections in clinical practice, affecting individuals across all age groups and healthcare settings. They account for a substantial proportion of outpatient visits, emergency department consultations, and hospital admissions worldwide. While many UTIs are traditionally considered uncomplicated and easily treatable, the growing emergence of multidrug-resistant (MDR) uropathogens has transformed what was once a manageable condition into a significant clinical and public health challenge. This shift is particularly concerning in low- and middle-income countries, where the burden of infectious diseases is already high and healthcare resources are often constrained(1, 2). The development of multidrug resistance among uropathogens has been closely linked to widespread and often inappropriate use of antibiotics, including empirical therapy without microbiological confirmation, over-the-counter availability of antimicrobials, and incomplete treatment courses. Common uropathogens such as *Escherichia coli*, *Klebsiella pneumoniae*, *Enterococcus* species, and *Pseudomonas aeruginosa* have increasingly demonstrated resistance to first-line and even second-line antibiotics, including beta-lactams, fluoroquinolones, and aminoglycosides. The rise of extended-spectrum beta-lactamase (ESBL)-producing organisms and carbapenem-resistant strains has further complicated treatment options, leading to prolonged hospital stays, increased healthcare costs, and higher rates of morbidity and mortality(3, 4).

In tertiary care hospitals, the problem of MDR UTIs is particularly pronounced due to the concentration of vulnerable patient populations. These settings frequently manage individuals with multiple comorbidities, indwelling urinary catheters, prior antibiotic exposure, and repeated hospitalizations, all of which are well-established risk factors for the acquisition of resistant infections. Additionally, tertiary care centers often serve as referral hubs, receiving complicated cases from peripheral facilities, thereby reflecting the cumulative effects of antimicrobial practices across different levels of the healthcare system. As a result, the clinical and microbiological profile of UTIs encountered in such hospitals may differ significantly from those seen in primary or secondary care(5, 6). Punjab, being the most populous province of Pakistan, carries a substantial share of the national healthcare burden. The region hosts a large network of tertiary care hospitals that cater to both urban and rural populations. Despite this, local data describing the patterns of multidrug-resistant UTIs in Punjab remain limited and fragmented. Many clinicians continue to rely on international guidelines or outdated regional studies when selecting empirical therapy, which may not accurately reflect current resistance trends. Given the dynamic nature of antimicrobial resistance, reliance on non-local or obsolete data can contribute to inappropriate prescribing practices and further exacerbate resistance(7, 8).

Understanding the clinical presentation of MDR UTIs is as important as identifying the causative organisms and their resistance profiles. Patients with resistant infections may present with atypical symptoms, recurrent infections, treatment failure, or rapid progression to complicated disease, including pyelonephritis and urosepsis. Recognizing these clinical patterns can aid clinicians in early suspicion of resistant infections and prompt timely microbiological evaluation. At the same time, detailed microbiological profiling provides essential information on prevalent pathogens and their susceptibility patterns, forming the cornerstone of evidence-based antimicrobial stewardship(9, 10). Although several studies have explored antimicrobial resistance in UTIs at a national or international level, there remains a notable gap in province-specific data that integrates both clinical characteristics and microbiological findings. The absence of comprehensive local evidence limits the effectiveness of hospital antibiotic policies and stewardship programs, which depend heavily on accurate, context-specific resistance data. Generating such evidence is critical not only for optimizing patient-level management but also for informing institutional guidelines and public health strategies aimed at curbing the spread of resistance(11, 12).

In this context, there is a clear need for systematic investigation into the clinical and microbiological profile of multidrug-resistant urinary tract infections in tertiary care hospitals of Punjab. By documenting patient characteristics, clinical presentations, causative organisms, and their antimicrobial resistance patterns, this study seeks to address an important evidence gap. The objective of the present research is to describe the clinical features and microbiological spectrum of MDR UTIs in tertiary care settings of Punjab, with the aim of providing locally relevant data to support rational antimicrobial use and strengthen antimicrobial stewardship initiatives(13).

METHODS

This descriptive observational study was conducted in tertiary care hospitals of Punjab, Pakistan, to evaluate the clinical and microbiological profile of multidrug-resistant urinary tract infections. The study was carried out across three large public sector tertiary care institutions, including Mayo Hospital Lahore, Allied Hospital Faisalabad, and Nishtar Medical University Hospital Multan. These centers were selected due to their high patient turnover, advanced diagnostic facilities, and representation of diverse urban and peri-urban populations from different regions of the province. The study was conducted over a period of eight months, from March 2022 to October 2022, allowing sufficient time for patient recruitment and microbiological analysis while minimizing seasonal bias(14). The study population comprised adult patients presenting with clinically suspected urinary tract infection who were admitted to inpatient departments or evaluated in outpatient and emergency settings of the selected hospitals. Patients aged 18 years and above with symptoms suggestive of UTI, including dysuria, urinary frequency, urgency, suprapubic discomfort, flank pain, or fever, were considered eligible. Inclusion required a positive urine culture demonstrating significant bacteriuria and subsequent identification of multidrug-resistant organisms, defined as resistance to at least one agent in three or more antimicrobial classes. Patients with polymicrobial contamination, fungal urinary infections, incomplete clinical records, or those who had received antimicrobial therapy for less than 48 hours prior to urine sampling were excluded. Pregnant women and patients with known structural urinary tract anomalies were also excluded to maintain clinical homogeneity(15).

The sample size was calculated using parameters derived from previously published regional studies reporting an estimated prevalence of multidrug-resistant uropathogens of approximately 35%. Using a confidence level of 95%, a margin of error of 5%, and applying the standard single-proportion formula, the minimum required sample size was calculated to be 350 patients. To account for potential data loss and incomplete laboratory results, the sample size was inflated by 10%, resulting in a final target sample of 385 participants. Consecutive sampling was employed until the required sample size was achieved(16). Data collection was carried out using a structured, pre-tested data collection proforma designed specifically for the study. Clinical data included patient demographics, presenting symptoms, comorbid conditions such as diabetes mellitus or chronic kidney disease, history of recent hospitalization, prior antibiotic use within the preceding three months, and presence of urinary catheterization. Urine samples were collected using midstream clean-catch technique for non-catheterized patients and aseptic sampling from catheter ports for catheterized individuals. All specimens were processed within one hour of collection in the microbiology laboratories of the respective hospitals(16).

Microbiological analysis involved urine culture on standard media, including cysteine lactose electrolyte-deficient agar and blood agar plates, followed by organism identification using conventional biochemical tests. Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method in accordance with Clinical and Laboratory Standards Institute guidelines. The antimicrobial panel included commonly prescribed agents such as cephalosporins, fluoroquinolones, aminoglycosides, carbapenems, and beta-lactam/beta-lactamase inhibitor combinations. Multidrug resistance was confirmed based on resistance patterns observed across multiple antibiotic classes(17). Outcome measures included the distribution of clinical features among patients with MDR UTIs, frequency of isolated uropathogens, and their antimicrobial resistance profiles. These outcomes were selected to align with the study objective of characterizing both clinical and microbiological aspects of MDR UTIs in tertiary care settings. Data were entered and analyzed using Statistical Package for the Social Sciences version 26. Continuous variables were expressed as mean and standard deviation, while categorical variables were presented as frequencies and percentages. As the data demonstrated normal distribution on preliminary assessment, inferential analysis was conducted using independent t-tests and one-way analysis of variance for continuous variables, and chi-square tests for categorical comparisons. A p-value of less than 0.05 was considered statistically significant(18).

Ethical approval for the study was obtained from the Institutional Review Board of King Edward Medical University, Lahore, under reference number IRB-KEMU-2022-091. Additional administrative permissions were secured from the participating hospitals. Written informed consent was obtained from all participants prior to enrollment, and confidentiality of patient information was strictly maintained by anonymizing data and restricting access to the research team only. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki, ensuring respect for participant autonomy, beneficence, and data integrity throughout the research process.

RESULTS

A total of 385 patients with culture-confirmed multidrug-resistant urinary tract infections were included in the final analysis. The mean age of the study population was 46.8 ± 15.2 years, with ages ranging from 18 to 82 years. Females constituted 232 (60.3%) of the cases, while 153 (39.7%) were males. Most patients were managed in inpatient settings ($n = 241$, 62.6%), followed by emergency departments ($n = 89$, 23.1%) and outpatient clinics ($n = 55$, 14.3%). A prior history of antibiotic use within the last three months was documented in 267 patients (69.4%), and indwelling urinary catheterization was present in 128 cases (33.2%). Diabetes mellitus was the most frequently reported comorbidity, observed in 171 patients (44.4%). The clinical presentation varied, with dysuria reported in 289 patients (75.1%), urinary frequency in 261 (67.8%), fever in 214 (55.6%), suprapubic pain in 176 (45.7%), and flank pain in 109 cases (28.3%). Recurrent UTI episodes were documented in 142 patients (36.9%). Mean duration of symptoms prior to presentation was 6.4 ± 3.1 days. Patients with a history of prior hospitalization demonstrated a significantly longer symptom duration compared to those without prior admissions (7.2 ± 3.4 vs. 5.6 ± 2.7 days, $p < 0.001$).

Microbiological analysis revealed *Escherichia coli* as the predominant uropathogen, isolated in 201 samples (52.2%), followed by *Klebsiella pneumoniae* in 96 (24.9%), *Pseudomonas aeruginosa* in 47 (12.2%), *Enterococcus* species in 29 (7.5%), and *Acinetobacter* species in 12 samples (3.1%). Extended-spectrum beta-lactamase production was detected in 183 isolates (47.5%), predominantly among *E. coli* and *Klebsiella* species. Carbapenem resistance was observed in 61 isolates (15.8%), with the highest proportion noted in *Pseudomonas aeruginosa*. Antimicrobial susceptibility testing demonstrated high resistance rates to commonly prescribed antibiotics. Resistance to third-generation cephalosporins was observed in 302 isolates (78.4%), fluoroquinolones in 287 (74.5%), and trimethoprim-sulfamethoxazole in 269 (69.9%). Aminoglycoside resistance was noted in 164 isolates (42.6%). Lower resistance rates were observed for carbapenems (15.8%) and nitrofurantoin (22.3%), particularly among *E. coli* isolates. Statistically significant differences in resistance patterns were observed between gram-negative and gram-positive organisms across all major antibiotic classes ($p < 0.05$).

Table 1. Clinical characteristics of patients with MDR UTIs ($n = 385$)

Variable	Frequency (%)
Female gender	232 (60.3)
Prior antibiotic use	267 (69.4)

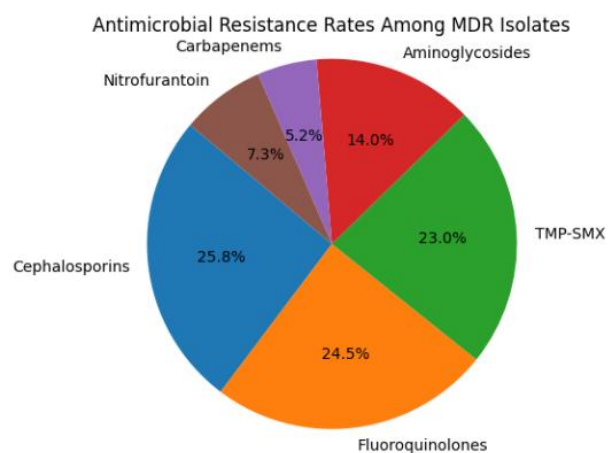
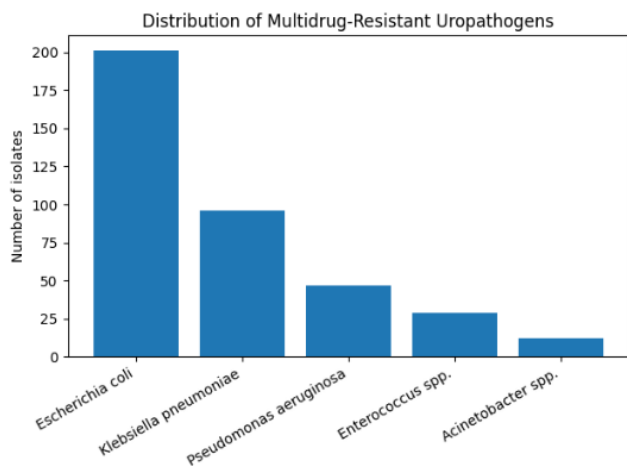
Diabetes mellitus	171 (44.4)
Indwelling catheter	128 (33.2)
Recurrent UTI	142 (36.9)
Fever	214 (55.6)

Table 2. Distribution of multidrug-resistant uropathogens

Organism	n (%)
<i>Escherichia coli</i>	201 (52.2)
<i>Klebsiella pneumoniae</i>	96 (24.9)
<i>Pseudomonas aeruginosa</i>	47 (12.2)
<i>Enterococcus</i> spp.	29 (7.5)
<i>Acinetobacter</i> spp.	12 (3.1)

Table 3. Antimicrobial resistance patterns of MDR isolates

Antibiotic class	Resistant isolates n (%)
Cephalosporins	302 (78.4)
Fluoroquinolones	287 (74.5)
TMP-SMX	269 (69.9)
Aminoglycosides	164 (42.6)
Carbapenems	61 (15.8)
Nitrofurantoin	86 (22.3)



DISCUSSION

The present study provided a detailed description of the clinical and microbiological characteristics of multidrug-resistant urinary tract infections in tertiary care hospitals of Punjab, reflecting contemporary resistance patterns within a high-burden healthcare setting. The findings demonstrated that MDR UTIs predominantly affected middle-aged adults, with a clear female predominance, and were frequently associated with prior antibiotic exposure, diabetes mellitus, and hospitalization. These observations aligned with regional and international evidence indicating that female gender and metabolic comorbidities significantly increase susceptibility to complicated and resistant urinary infections. In this cohort, females accounted for just over 60% of cases, a proportion comparable to previously reported ranges of 55–65% in similar hospital-based studies, reinforcing the persistent gender disparity in UTI burden even in resistant infections(19). Clinically, dysuria, urinary frequency, and fever were the most commonly reported symptoms, together affecting more than half of the study population. Notably, over one-third of patients had a documented history of recurrent UTIs, and nearly one-third were catheterized at presentation. These figures were consistent with earlier reports from tertiary care settings in South Asia, where recurrent infections have been documented in approximately

30–40% of MDR UTI cases. The significantly longer symptom duration observed among previously hospitalized patients highlighted the clinical complexity and delayed resolution often associated with resistant infections, underscoring the cumulative impact of repeated healthcare exposure(20).

From a microbiological perspective, *Escherichia coli* remained the dominant uropathogen, accounting for just over half of all isolates, followed by *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. This distribution mirrored established epidemiological trends, where *E. coli* typically contributes 50–70% of UTI cases, even in the presence of multidrug resistance. The substantial proportion of *Klebsiella* and *Pseudomonas* isolates in this study reflected the tertiary care environment, where opportunistic and hospital-acquired pathogens are more prevalent. The detection of extended-spectrum beta-lactamase production in nearly half of the isolates was particularly concerning and comparable to previously reported ESBL rates ranging from 40% to 55% in hospital-based studies from Pakistan(1). Antimicrobial susceptibility patterns revealed alarmingly high resistance rates to commonly used empirical agents. Resistance to third-generation cephalosporins exceeded 75%, while fluoroquinolone resistance approached similar levels. These findings were in line with recent regional surveillance data indicating cephalosporin resistance rates between 70% and 85% among MDR uropathogens. Such resistance substantially limits first-line treatment options and increases reliance on broader-spectrum agents. In contrast, carbapenem resistance remained comparatively lower at approximately 16%, and nitrofurantoin demonstrated preserved activity in a significant proportion of isolates, particularly against *E. coli*. This pattern echoed prior observations suggesting that nitrofurantoin retains clinical utility for uncomplicated infections, even in high-resistance settings, while carbapenems continue to serve as critical reserve agents(5).

The implications of these findings were clinically significant. The high prevalence of resistance to widely prescribed antibiotics reinforced the need for routine culture and sensitivity testing before initiating therapy, particularly in patients with recurrent infections or prior antibiotic exposure. The data also highlighted the importance of local antibiograms in guiding empirical treatment, as reliance on outdated or non-local guidelines may contribute to treatment failure and further resistance development. From an antimicrobial stewardship perspective, the observed resistance patterns supported the rational restriction of broad-spectrum antibiotics and the promotion of targeted therapy based on microbiological evidence(9). Several strengths of the study enhanced the reliability of its findings. The inclusion of multiple tertiary care hospitals across different regions of Punjab improved the representativeness of the data, while the relatively large sample size allowed for robust description of clinical and microbiological trends. Standardized laboratory methods and adherence to established susceptibility testing guidelines further strengthened the validity of the microbiological results(11).

However, certain limitations warranted consideration. The descriptive design precluded causal inferences regarding risk factors for resistance, and molecular characterization of resistance mechanisms was not performed, limiting insights into genetic determinants. Additionally, the exclusion of pediatric and pregnant populations restricted the generalizability of the findings to adult patients only. Future studies incorporating longitudinal designs, molecular resistance profiling, and outcome-based analyses could provide deeper understanding of resistance dynamics and treatment effectiveness(14). Overall, the study highlighted a substantial burden of multidrug-resistant UTIs in tertiary care settings of Punjab, characterized by high resistance to commonly used antibiotics and a predominance of gram-negative pathogens. These findings emphasized the urgent need for strengthened antimicrobial stewardship, continuous local surveillance, and evidence-based prescribing practices to mitigate the growing challenge of antimicrobial resistance.

CONCLUSION

This study demonstrated a high burden of multidrug-resistant urinary tract infections in tertiary care hospitals of Punjab, with gram-negative organisms, particularly *Escherichia coli* and *Klebsiella pneumoniae*, predominating and showing marked resistance to commonly used antibiotics. The findings underscore the limited effectiveness of empirical therapy and highlight the critical role of routine culture-based diagnosis. Locally generated resistance data from this study provide practical guidance for antimicrobial stewardship and informed antibiotic selection in tertiary care settings.

AUTHOR'S CONTRIBUTION:

Author	Contribution
Dr Maryam Shakoor	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Hina Shakor	Methodology, Investigation, Data Curation, Writing - Review & Editing
Kashaf Shakoor	Investigation, Data Curation, Formal Analysis, Software
Abdullah Ali Khan	Software, Validation, Writing - Original Draft
Dr Syeda Maimona Tahira	Formal Analysis, Writing - Review & Editing
Dr Rubab Vaseer	Writing - Review & Editing, Assistance with Data Curation

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