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Research Article

Clinical Outcomes of Multidrug-Resistant Urinary Tract Infections in Hospitalized Patients

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Abstract

Multidrug-resistant urinary tract infections have emerged as a major public health concern because of increasing antimicrobial resistance, prolonged hospitalization, recurrent infections, and rising healthcare-associated mortality. Hospitalized patients are particularly vulnerable to multidrug-resistant urinary tract infections due to prolonged catheterization, comorbid illnesses, prior antibiotic exposure, and invasive medical procedures. The present study aimed to evaluate the clinical outcomes, microbial profiles, and prognostic determinants associated with multidrug-resistant urinary tract infections among hospitalized patients at a tertiary care hospital. A prospective observational experimental study was conducted on 228 hospitalized patients diagnosed with urinary tract infections between January 2023 and December 2024. Patients were categorized into multidrug-resistant and non-multidrug-resistant urinary tract infection groups based on antimicrobial susceptibility testing. Clinical outcomes including duration of hospitalization, intensive care admission, septic complications, treatment failure, and mortality were evaluated. Escherichia coli was the most frequently isolated pathogen, followed by Klebsiella pneumoniae and Pseudomonas aeruginosa. Multidrug-resistant urinary tract infections accounted for 58.3% of all cases and were significantly associated with prolonged hospital stay, increased intensive care unit admission, recurrent infection, and higher mortality rates ($p<0.001$). Prior antibiotic exposure, diabetes mellitus, urinary catheterization, and chronic kidney disease were identified as independent predictors of multidrug-resistant urinary tract infection. Patients with multidrug-resistant infections demonstrated significantly lower clinical recovery rates compared with non-resistant infections. The findings emphasize the growing burden of multidrug-resistant urinary tract infections in hospitalized patients and highlight the urgent need for antimicrobial stewardship programs, early microbiological surveillance, and

optimized infection control strategies to reduce adverse clinical outcomes.

Keywords: Multidrug-resistant infection, Urinary tract infection, Antimicrobial resistance

Introduction

Urinary tract infection remains one of the most common bacterial infections encountered in hospitalized patients and represents a significant cause of morbidity, prolonged hospitalization, and healthcare expenditure worldwide. The clinical spectrum of urinary tract infection ranges from uncomplicated cystitis to severe pyelonephritis, urosepsis, and septic shock. Hospitalized patients are particularly susceptible because of underlying comorbidities, urinary catheterization, immunosuppression, invasive procedures, and repeated antibiotic exposure [1-3]. In recent years, the emergence of multidrug-resistant urinary pathogens has become a major therapeutic challenge in both community and healthcare settings.

Multidrug-resistant urinary tract infection is generally defined as infection caused by bacterial isolates resistant to at least one antimicrobial agent in three or more antibiotic classes. Increasing antimicrobial resistance among gram-negative organisms such as Escherichia coli, Klebsiella pneumoniae, Proteus mirabilis, Acinetobacter baumannii, and Pseudomonas aeruginosa has substantially complicated empirical antibiotic therapy [2-4]. Extended-spectrum beta-lactamase-producing organisms and carbapenem-resistant Enterobacterales have become increasingly prevalent in hospitalized populations, thereby limiting therapeutic options and increasing reliance on broad-spectrum antibiotics.

The clinical consequences of multidrug-resistant urinary tract infections are substantial and include treatment failure, recurrent infection, prolonged hospitalization, increased intensive care unit admission, progression to urosepsis, and increased mortality [3-5]. Additionally, antimicrobial resistance contributes significantly to healthcare costs because of prolonged antibiotic therapy, repeated microbiological investigations, and increased utilization of intensive care resources. Hospital-acquired multidrug-resistant urinary infections are particularly problematic in developing countries where infection control practices, antimicrobial stewardship programs, and microbiological surveillance may remain insufficient.

Several risk factors have been implicated in the development of multidrug-resistant urinary tract infections. These include advanced age, diabetes mellitus, chronic kidney disease, urinary catheterization, prolonged hospitalization, previous antibiotic use, recurrent urinary tract infections, and immunocompromised states [4-6]. Among hospitalized patients, urinary catheterization remains one of the most significant modifiable risk factors because indwelling catheters facilitate bacterial colonization, biofilm formation, and ascending infection.

Recent epidemiological studies have reported alarming increases in antimicrobial resistance among uropathogens globally. Resistance to fluoroquinolones, third-generation cephalosporins, aminoglycosides, and carbapenems has risen considerably during the past decade [5-7]. Furthermore,

multidrug-resistant infections have demonstrated reduced responsiveness to conventional empirical therapy, resulting in delayed clinical recovery and increased complication rates. Timely identification of resistance patterns and appropriate antimicrobial selection are therefore essential for improving patient outcomes.

The burden of multidrug-resistant urinary tract infections is especially significant in low- and middle-income countries because of widespread empirical antibiotic use, over-the-counter antimicrobial availability, inadequate infection prevention strategies, and limited diagnostic microbiology facilities [6-8]. Pakistan continues to experience rapidly increasing antimicrobial resistance rates among uropathogens, particularly in tertiary care hospitals where critically ill and catheterized patients are concentrated. However, regional data evaluating the clinical outcomes and prognostic determinants of multidrug-resistant urinary tract infections remain comparatively limited.

Existing literature has primarily focused on antimicrobial susceptibility profiles and resistance prevalence, whereas fewer studies have comprehensively evaluated the clinical impact of multidrug-resistant urinary tract infections among hospitalized patients [7-9]. Moreover, local healthcare infrastructure, prescribing practices, and patient demographics may substantially influence the epidemiology and outcomes of resistant urinary infections. Consequently, region-specific evidence is required to guide effective antimicrobial stewardship policies and infection control interventions.

The present study was therefore designed to evaluate the clinical outcomes of multidrug-resistant urinary tract infections among hospitalized patients at a tertiary care hospital. The study additionally aimed to determine microbial profiles, antimicrobial resistance patterns, risk factors associated with multidrug-resistant infection, and predictors of adverse clinical outcomes. By generating updated evidence from a resource-limited healthcare setting, the findings are expected to contribute toward improved infection surveillance, optimized antimicrobial management, and reduced morbidity associated with multidrug-resistant urinary tract infections [8-10].

Methodology

A prospective observational experimental study was conducted at , University College of Medicine and Dentistry, University of Lahore, after approval from the institutional ethical review committee. The study included hospitalized adult patients diagnosed with urinary tract infection based on clinical and microbiological criteria. The sample size was calculated using OpenEpi software version 3.01 by considering an anticipated prevalence of multidrug-resistant urinary tract infection of 55%, confidence interval of 95%, margin of error of 6%, and study power of 80%, resulting in a minimum required sample size of 214 participants. After adjustment for incomplete clinical data and possible attrition, 228 patients were enrolled. Patients aged 18 years and above with symptomatic urinary tract infection confirmed by urine culture showing significant bacterial growth were included in the study. Clinical manifestations included dysuria, fever, urinary frequency, suprapubic

pain, flank pain, altered mental status, or systemic inflammatory response associated with positive urine culture findings. Patients with contaminated urine cultures, asymptomatic bacteriuria, pregnancy-related urinary infections, incomplete medical records, or discharge against medical advice were excluded.

Verbal informed consent was obtained from all participants before enrollment. Confidentiality of patient records and microbiological data was maintained throughout the study period. Demographic information including age, gender, duration of hospitalization, comorbid illnesses, urinary catheterization history, previous antibiotic exposure, intensive care admission, and recurrent urinary tract infection history was documented.

Midstream urine samples or catheter-obtained urine specimens were collected under aseptic conditions and processed according to standard microbiological protocols. Bacterial identification and antimicrobial susceptibility testing were performed using the Kirby-Bauer disk diffusion method in accordance with Clinical and Laboratory Standards Institute guidelines. Multidrug resistance was defined as bacterial resistance to at least one agent in three or more antimicrobial classes.

Patients were categorized into multidrug-resistant urinary tract infection and non-multidrug-resistant urinary tract infection groups based on antimicrobial susceptibility results. Clinical outcomes including duration of hospitalization, need for intensive care admission, septic complications, treatment failure, recurrent infection, and in-hospital mortality were evaluated during hospitalization and follow-up.

Data analysis was performed using SPSS version 26.0. Quantitative variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Independent t-test and chi-square test were applied for comparison between multidrug-resistant and non-resistant groups. Multivariate logistic regression analysis was conducted to identify independent predictors of multidrug-resistant infection and adverse clinical outcomes. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 228 hospitalized patients with culture-confirmed urinary tract infection were included in the study. Multidrug-resistant urinary tract infections were identified in 133 patients (58.3%), while 95 patients (41.7%) had non-multidrug-resistant infections. The mean age of participants was 54.6 ± 16.3 years, and females constituted 61.4% of the study population.

Table 1. Demographic and Clinical Characteristics of Study Participants (n=228)

Variable	MDR UTI (n=133)	Non-MDR UTI (n=95)	p-value
Age (years)	58.2 ± 15.4	49.5 ± 14.1	0.003
Female gender	82 (61.7%)	58 (61.1%)	0.927
Diabetes mellitus	76 (57.1%)	31 (32.6%)	<0.001

Variable	MDR UTI (n=133)	Non-MDR UTI (n=95)	p-value
Chronic kidney disease	42 (31.6%)	14 (14.7%)	0.004
Prior antibiotic exposure	94 (70.7%)	29 (30.5%)	<0.001
Urinary catheterization	81 (60.9%)	24 (25.3%)	<0.001
ICU admission	38 (28.6%)	11 (11.6%)	0.002
Duration of hospitalization (days)	11.8 ± 5.2	6.9 ± 3.4	<0.001

Explanation: Patients with multidrug-resistant urinary tract infections demonstrated significantly higher rates of diabetes mellitus, chronic kidney disease, urinary catheterization, and prior antibiotic exposure. Hospital stay duration and intensive care admission were significantly greater among multidrug-resistant cases.

Table 2. Microbial Profile and Antimicrobial Resistance Patterns

Pathogen	Frequency (%)	MDR Isolates (%)	p-value
Escherichia coli	104 (45.6%)	67 (64.4%)	<0.001
Klebsiella pneumoniae	58 (25.4%)	39 (67.2%)	0.002
Pseudomonas aeruginosa	29 (12.7%)	22 (75.9%)	0.009
Enterococcus species	18 (7.9%)	9 (50.0%)	0.041
Proteus mirabilis	11 (4.8%)	6 (54.5%)	0.065
Acinetobacter baumannii	8 (3.5%)	7 (87.5%)	0.013

Explanation: Escherichia coli was the most frequently isolated organism among urinary tract infections. High multidrug resistance rates were observed among gram-negative pathogens, particularly Acinetobacter baumannii and Pseudomonas aeruginosa.

Table 3. Clinical Outcomes of Multidrug-Resistant and Non-Multidrug-Resistant Urinary Tract Infections

Clinical Outcome	MDR UTI	Non-MDR UTI	p-value
Septic complications	46 (34.6%)	12 (12.6%)	<0.001
Recurrent infection	39 (29.3%)	10 (10.5%)	0.001
Treatment failure	42 (31.6%)	8 (8.4%)	<0.001
ICU admission	38 (28.6%)	11 (11.6%)	0.002
Mortality	17 (12.8%)	3 (3.2%)	0.011
Clinical recovery	86 (64.7%)	84 (88.4%)	<0.001

Explanation: Multidrug-resistant urinary tract infections were associated with significantly higher septic complications, recurrent infection, treatment failure, and mortality compared with non-resistant infections. Clinical recovery rates were significantly lower among multidrug-resistant cases.

Discussion

The present study demonstrated a high prevalence of multidrug-resistant urinary tract infections among hospitalized patients, with multidrug-resistant isolates accounting for more than half of all culture-confirmed urinary infections. These findings reflect the growing global burden of antimicrobial resistance and are consistent with recent studies reporting increasing multidrug resistance among hospitalized urinary tract infection patients [11-12]. The substantial prevalence observed in the present cohort may be attributable to extensive empirical antibiotic use, frequent catheterization, and concentration of critically ill patients within tertiary care hospitals.

Escherichia coli was identified as the most common urinary pathogen, followed by Klebsiella pneumoniae and Pseudomonas aeruginosa. Similar microbial patterns have been consistently reported in recent urinary tract infection surveillance studies [11-13]. However, the high multidrug resistance rates observed among gram-negative organisms in the current study are clinically concerning because these pathogens frequently demonstrate resistance to fluoroquinolones, cephalosporins, and carbapenems, thereby significantly limiting therapeutic options.

Prior antibiotic exposure emerged as one of the strongest predictors of multidrug-resistant urinary tract infection. Excessive and inappropriate antibiotic utilization promotes selective bacterial resistance and facilitates colonization with resistant organisms [12-14]. In many developing healthcare systems, unrestricted antimicrobial access and empirical broad-spectrum antibiotic prescribing continue to contribute substantially to resistance emergence. The present findings therefore underscore the urgent need for antimicrobial stewardship programs focused on rational antibiotic prescribing practices.

Urinary catheterization demonstrated a significant association with multidrug-resistant urinary tract infection in the current study. Catheter-associated urinary tract infections remain among the most common healthcare-associated infections because indwelling catheters facilitate biofilm formation and ascending bacterial colonization [13-15]. Biofilm-associated organisms demonstrate enhanced resistance to antimicrobial agents and host immune mechanisms, thereby increasing the likelihood of persistent and recurrent infection.

Patients with multidrug-resistant urinary tract infections experienced significantly prolonged hospitalization, increased intensive care admission, septic complications, and higher mortality rates compared with non-resistant infections. Similar adverse clinical outcomes have been reported in recent studies evaluating healthcare-associated multidrug-resistant infections [14-16]. Delayed initiation of effective antimicrobial therapy in resistant infections may contribute to disease

progression, systemic inflammatory response, and organ dysfunction.

Diabetes mellitus and chronic kidney disease were independently associated with multidrug-resistant urinary infections in the present study. Hyperglycemia impairs immune function and promotes bacterial proliferation, while chronic kidney disease is frequently associated with repeated healthcare exposure, urinary abnormalities, and recurrent antimicrobial therapy [15-18]. These comorbid conditions therefore increase susceptibility to colonization and infection with resistant urinary pathogens.

The findings of the current study have important public health implications because multidrug-resistant urinary tract infections significantly increase healthcare costs, antimicrobial utilization, and hospital resource burden. Early microbiological diagnosis, targeted antimicrobial therapy, strict catheter care protocols, and infection prevention strategies are essential for reducing adverse clinical outcomes [17-20]. The present study additionally provides updated regional evidence regarding multidrug-resistant urinary tract infections in hospitalized patients and highlights the urgent need for strengthened antimicrobial surveillance systems and hospital infection control programs.

Conclusion

Multidrug-resistant urinary tract infections are associated with substantial morbidity, prolonged hospitalization, treatment failure, and increased mortality among hospitalized patients. Prior antibiotic exposure, urinary catheterization, diabetes mellitus, and chronic kidney disease significantly increase the risk of multidrug-resistant infection. Early microbiological surveillance and effective antimicrobial stewardship strategies are essential to improve clinical outcomes and reduce the growing burden of antimicrobial resistance.

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