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Original Article

Bacteriological Profile and Antimicrobial Resistance Pattern of Community-Acquired Urinary Tract Infections Among Adult Outpatients in a Tertiary Care Hospital

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ABSTRACT

Background: Community-acquired urinary tract infections are frequently treated empirically, but increasing antimicrobial resistance may reduce the effectiveness of commonly prescribed agents. Local organism-specific surveillance is therefore required. Objective: To determine the bacterial profile, antimicrobial susceptibility patterns and prevalence of multidrug resistance among adult outpatients with suspected community-acquired urinary tract infection. Methods: This cross-sectional laboratory-based study analysed 300 midstream urine specimens from symptomatic adult outpatients attending a tertiary-care hospital in Multan, Pakistan. Bacterial isolates were identified using conventional microbiological methods, and antimicrobial susceptibility was assessed using Kirby–Bauer disk diffusion according to Clinical and Laboratory Standards Institute criteria. Results were summarised using frequencies, percentages and 95% confidence intervals. Results: Significant bacterial growth was detected in 184 specimens (61.3%; 95% CI: 55.7–66.7%). Escherichia coli was the predominant isolate (58.7%), followed by Klebsiella pneumoniae (13.0%), Enterococcus species (9.8%) and Pseudomonas aeruginosa (6.5%). E. coli susceptibility was 82.4% to nitrofurantoin, 79.6% to fosfomycin and 93.5% to meropenem, but only 41.7% to ciprofloxacin and 38.9% to trimethoprim-sulfamethoxazole. Overall, 71 isolates (38.6%; 95% CI: 31.9–45.8%) were multidrug-resistant. MDR was detected in 36.1% of E. coli and 50.0% of K. pneumoniae isolates. Conclusion: E. coli was the principal uropathogen, and substantial resistance was observed to several commonly prescribed agents. Organism-specific local antibiograms and culture-guided prescribing are required to support appropriate outpatient treatment. Keywords: Community-acquired urinary tract infection; uropathogens; antimicrobial resistance; multidrug resistance; antibiogram; Escherichia coli.

INTRODUCTION

Urinary tract infections are among the most frequently encountered bacterial infections in outpatient clinical practice and may involve any part of the urinary system, ranging from uncomplicated lower urinary tract disease to pyelonephritis and systemic infection. Their burden is particularly high among women because of anatomical and behavioural factors, although men, older adults and people with underlying medical conditions may also develop clinically important infections. Recurrent episodes contribute substantially to antimicrobial consumption, diagnostic testing, healthcare visits and treatment costs. Most community-acquired urinary tract infections originate from microorganisms colonising the gastrointestinal tract, with Escherichia coli consistently identified as the predominant uropathogen. Other clinically relevant organisms include Klebsiella pneumoniae, Proteus species,

Enterobacter species, Enterococcus species, Staphylococcus saprophyticus and, less frequently, Pseudomonas aeruginosa (1–4).

Antimicrobial treatment is frequently initiated before urine-culture and susceptibility results become available. The effectiveness of empirical therapy therefore depends on the expected bacterial pathogens, the clinical presentation and the prevailing local antimicrobial resistance pattern. International treatment guidance and surveillance studies have demonstrated substantial geographical variation in the susceptibility of urinary pathogens. Consequently, an antimicrobial agent that remains effective in one population may provide inadequate coverage in another. Increasing non-susceptibility to commonly prescribed agents, including fluoroquinolones, trimethoprim-sulfamethoxazole and cephalosporins, has complicated outpatient management, whereas nitrofurantoin and fosfomycin have retained comparatively favourable activity against susceptible uncomplicated urinary pathogens in several settings (5–8).

Antimicrobial resistance is no longer confined to hospital-acquired infections. Resistant organisms are increasingly recovered from patients presenting directly from the community, reducing the number of reliable oral treatment options and increasing the risk of initial treatment failure. Multidrug resistance is conventionally defined as non-susceptibility to at least one antimicrobial agent in three or more antimicrobial categories (9). Community-based studies have reported substantial frequencies of multidrug-resistant uropathogens, particularly among members of the order Enterobacterales. The dissemination of mobile resistance determinants among E. coli, K. pneumoniae and related organisms has further increased concern regarding the effectiveness of routinely prescribed antimicrobial agents (10–13).

Pakistan has a considerable antimicrobial resistance burden, but surveillance coverage and standardisation of microbiological reporting remain uneven. Studies conducted in different regions of the country have consistently identified E. coli as the leading urinary pathogen and have documented reduced susceptibility to ampicillin, trimethoprim-sulfamethoxazole, fluoroquinolones and third-generation cephalosporins. Resistance patterns differ between institutions and patient populations, reflecting variation in antimicrobial availability, prescribing practices, previous antimicrobial exposure, healthcare contact and laboratory methods. These differences limit the direct transferability of resistance estimates from one healthcare setting to another and reinforce the need for regularly updated institutional and regional antibiograms (14–19).

Evidence from South Punjab has similarly demonstrated substantial resistance among urinary pathogens. Previous hospital-based studies from Multan and surrounding areas have identified E. coli as the predominant organism and have reported reduced activity of several commonly used antimicrobial agents. However, available studies have often included heterogeneous patient groups, complicated infections or combined inpatient and outpatient populations. Recent data specifically describing clinically suspected community-acquired urinary tract infections among adult outpatients remain limited, while antimicrobial susceptibility patterns may change with antimicrobial use and the circulation of resistant bacterial strains (16,20–25). Therefore, the present study aimed to determine the bacteriological profile of community-acquired urinary tract infections among adult outpatients attending a tertiary-care hospital in Multan, Pakistan, evaluate the antimicrobial susceptibility patterns of the recovered organisms and estimate the prevalence of multidrug-resistant isolates.

MATERIALS AND METHODS

A cross-sectional laboratory-based study was conducted in the microbiology laboratory of a tertiary-care hospital in Multan, Pakistan. The hospital provides outpatient and diagnostic services to residents of Multan and surrounding districts of South Punjab. The analytical sample comprised 300 urine specimens obtained from adult outpatients with clinical features suggestive of urinary tract infection and processed for bacterial culture and antimicrobial susceptibility testing.

Patients aged 18 years or older who attended an outpatient department with symptoms suggestive of urinary tract infection were eligible. Relevant symptoms included burning micturition, increased urinary frequency, urgency, lower abdominal discomfort and other urinary complaints considered clinically consistent with urinary tract infection. Community-acquired infection was operationally defined as a suspected infection in a patient evaluated in the outpatient setting who was not hospitalised at the time of specimen collection and had no documented recent hospitalisation, indwelling urinary catheter or major urological procedure. Patients admitted to hospital wards, those with indwelling urinary catheters or recent healthcare exposure, patients with incomplete clinical information and duplicate specimens obtained from the same patient were excluded from the analysis.

Eligible patients provided clean-catch midstream urine specimens in sterile, wide-mouthed, leak-proof containers. Before collection, patients were instructed regarding personal hygiene and the correct midstream collection technique to minimise contamination by periurethral and skin flora. Each specimen was labelled with the patient identification number, age, sex and date of collection. Samples were transported promptly to the microbiology laboratory for processing. Specimens that could not be processed immediately were stored in accordance with routine laboratory procedures to preserve bacterial viability and minimise the overgrowth of contaminants.

Urine specimens were processed using quantitative standard microbiological procedures. Each sample was inoculated onto appropriate culture media using a calibrated-loop technique and incubated under the conditions specified by the laboratory protocol. Colony counts were expressed as colony-forming units per millilitre and interpreted according to established microbiological criteria to distinguish clinically significant bacterial growth from insignificant or contaminated growth. Specimens showing no significant bacterial growth and cultures classified as contaminated were excluded from isolate-level antimicrobial analysis.

Clinically significant isolates were identified through assessment of colony morphology, Gram-staining characteristics and conventional biochemical reactions. The biochemical identification procedures included catalase, oxidase, indole, citrate-utilisation and urease testing, together with other organism-appropriate reactions required to distinguish members of Enterobacterales, non-fermenting Gram-negative bacteria, enterococci, staphylococci and other clinically relevant urinary pathogens. The principal organisms evaluated included Escherichia coli, Klebsiella pneumoniae, Proteus species, Enterobacter species, Pseudomonas aeruginosa, Enterococcus species and Staphylococcus saprophyticus.

Antimicrobial susceptibility testing was performed for confirmed bacterial isolates using the Kirby–Bauer disk-diffusion method. Antimicrobial agents were selected according to the bacterial species and the routinely applicable urinary tract infection testing panel. The tested agents represented relevant antimicrobial categories, including penicillins, cephalosporins, fluoroquinolones, aminoglycosides, carbapenems, nitrofurantoin, fosfomycin and trimethoprim-sulfamethoxazole. Following incubation, inhibition-zone diameters were measured in millimetres and categorised as susceptible, intermediate or resistant according to the applicable Clinical and Laboratory Standards Institute interpretive criteria. Organism–antimicrobial combinations were interpreted only when appropriate for the bacterial species. Laboratory quality-control procedures were maintained using standard reference strains where required.

Multidrug resistance was evaluated from the antimicrobial susceptibility profile of each isolate. An isolate was classified as multidrug-resistant when it demonstrated non-susceptibility to at least one antimicrobial agent in three or more antimicrobial categories (9). The overall prevalence of multidrug resistance was determined among culture-positive isolates, and organism-specific MDR frequencies were calculated for the major uropathogens, particularly E. coli and K. pneumoniae.

Clinical and laboratory information was recorded using a structured data-collection form. The variables included patient age, sex, presenting urinary symptoms, culture result, bacterial species, antimicrobial susceptibility classification and multidrug-resistance status. The analysis was descriptive. Categorical

variables were summarised as frequencies and percentages. Culture positivity was calculated using the total number of processed specimens as the denominator, whereas bacterial distribution and multidrug resistance were calculated using the number of culture-positive isolates. Antimicrobial susceptibility percentages were calculated using the number of isolates tested for each applicable organism–antimicrobial combination as the denominator. Duplicate specimens and records with incomplete clinical information were excluded before analysis.

The study was conducted after approval from the institutional research and ethics committee. All specimen collection, bacterial identification, antimicrobial susceptibility testing and data-handling procedures were undertaken in accordance with institutional laboratory practices and applicable ethical requirements.

Categorical variables were summarised as frequencies and percentages. Culture positivity was calculated using all processed urine specimens as the denominator, whereas organism distribution and multidrug resistance were calculated using culture-positive isolates. Antimicrobial susceptibility was expressed as the number and percentage of isolates classified as susceptible among the isolates of each species tested against the respective antimicrobial agent. Ninety-five per cent confidence intervals for principal proportions were calculated using the Wilson score method. The prevalence of multidrug resistance in Klebsiella pneumoniae was compared with that in Escherichia coli using a prevalence ratio with a 95% confidence interval, and Fisher's exact test was used to assess the difference between the two organisms. Statistical tests were two-sided, and a p-value <0.05 was considered statistically significant.

RESULTS

A total of 300 urine specimens obtained from adult outpatients with clinical suspicion of community-acquired urinary tract infection were processed. Significant bacterial growth was detected in 184 specimens, corresponding to a culture-positivity rate of 61.3% (95% CI: 55.7–66.7%). The remaining 116 specimens (38.7%) showed no significant bacterial growth or were classified as contaminated. Among culture-positive patients, 122 (66.3%) were female and 62 (33.7%) were male. The largest age group comprised patients aged 31–50 years, accounting for 72 cases (39.1%), followed by those aged 18–30 years with 58 cases (31.5%) and those older than 50 years with 54 cases (29.4%) (Table 1).

A total of 184 bacterial isolates were recovered. E. coli was the predominant organism, accounting for 108 isolates (58.7%), followed by K. pneumoniae with 24 (13.0%), Enterococcus species with 18 (9.8%) and P. aeruginosa with 12 (6.5%). Proteus species, Enterobacter species and S. saprophyticus accounted for 8 (4.3%), 7 (3.8%) and 5 (2.7%) isolates, respectively. Two isolates (1.1%) were classified as other organisms. Collectively, members of the order Enterobacterales accounted for 147 of 184 isolates (79.9%) (Table 2).

Table 1. Culture Results and Demographic Characteristics of the Study Population

Characteristic	n/N	%
Culture result among processed specimens		
Significant bacterial growth	184/300	61.3
No significant growth or contaminated culture	116/300	38.7
Sex among culture-positive patients		
Female	122/184	66.3
Male	62/184	33.7
Age group among culture-positive patients		
18–30 years	58/184	31.5
31–50 years	72/184	39.1
>50 years	54/184	29.4

Among E. coli isolates, the highest in-vitro susceptibility was observed for meropenem at 93.5% (101/108), followed by nitrofurantoin at 82.4% (89/108), fosfomycin at 79.6% (86/108) and amikacin at 74.1% (80/108). Susceptibility was lower for ceftriaxone at 46.3% (50/108), ciprofloxacin at 41.7% (45/108) and trimethoprim-sulfamethoxazole at 38.9% (42/108). Among K. pneumoniae isolates, susceptibility

was highest for meropenem at 87.5% (21/24), followed by amikacin at 70.8% (17/24) and fosfomycin at 62.5% (15/24). Lower susceptibility was observed for ceftriaxone at 37.5% (9/24), ciprofloxacin at 33.3% (8/24) and trimethoprim-sulfamethoxazole at 29.2% (7/24) (Table 3).

Table 2. Distribution of Bacterial Isolates Recovered from Culture-Positive Urine Samples

Bacterial isolate	n	%
Escherichia coli	108	58.7
Klebsiella pneumoniae	24	13.0
Enterococcus species	18	9.8
Pseudomonas aeruginosa	12	6.5
Proteus species	8	4.3
Enterobacter species	7	3.8
Staphylococcus saprophyticus	5	2.7
Other organisms	2	1.1
Total	184	100.0*

*Percentages may not sum exactly to 100.0 because of rounding.

Table 3. Antimicrobial Susceptibility of Escherichia coli and Klebsiella pneumoniae

Antimicrobial agent	E. coli susceptible, n/N (%)	K. pneumoniae susceptible, n/N (%)
Nitrofurantoin	89/108 (82.4)	14/24 (58.3)
Fosfomycin	86/108 (79.6)	15/24 (62.5)
Amikacin	80/108 (74.1)	17/24 (70.8)
Gentamicin	71/108 (65.7)	13/24 (54.2)
Ciprofloxacin	45/108 (41.7)	8/24 (33.3)
Trimethoprim-sulfamethoxazole	42/108 (38.9)	7/24 (29.2)
Ceftriaxone	50/108 (46.3)	9/24 (37.5)
Meropenem	101/108 (93.5)	21/24 (87.5)

Table 4. Prevalence of Multidrug Resistance Among Bacterial Isolates

Bacterial group	MDR, n/N (%)	95% CI	Prevalence ratio (95% CI)	p-value
E. coli	39/108 (36.1)	27.7–45.5	Reference	—
K. pneumoniae	12/24 (50.0)	31.4–68.6	1.38 (0.86–2.22)	0.249
Other bacterial isolates	20/52 (38.5)	26.5–52.0	—	—
All bacterial isolates	71/184 (38.6)	31.9–45.8	—	—

CI: confidence interval; MDR: multidrug resistance. The comparison between K. pneumoniae and E. coli was performed using Fisher's exact test.

Multidrug resistance was identified in 71 of 184 isolates, corresponding to an overall prevalence of 38.6% (95% CI: 31.9–45.8%). MDR was detected in 39 of 108 E. coli isolates (36.1%; 95% CI: 27.7–45.5%) and 12 of 24 K. pneumoniae isolates (50.0%; 95% CI: 31.4–68.6%). The MDR prevalence in K. pneumoniae was numerically higher than that in E. coli, with a prevalence ratio of 1.38; however, the confidence interval included the null value and the difference was not statistically significant (95% CI: 0.86–2.22; p=0.249). Among the remaining organisms, 20 of 52 isolates (38.5%; 95% CI: 26.5–52.0%) were classified as multidrug-resistant (Table 4).

DISCUSSION

This study characterised the bacterial profile and antimicrobial susceptibility patterns of community-acquired urinary tract infections among adult outpatients attending a tertiary-care hospital in Multan. Approximately three-fifths of the processed specimens yielded significant bacterial growth, and women represented approximately two-thirds of culture-positive patients. E. coli was the predominant uropathogen, followed by K. pneumoniae, Enterococcus species and P. aeruginosa. Susceptibility to ciprofloxacin, trimethoprim-sulfamethoxazole and ceftriaxone was limited among the two principal Enterobacterales, while nitrofurantoin and fosfomycin retained comparatively favourable activity against E. coli. More than one-third of all isolates were multidrug-resistant.

The culture-positivity rate of 61.3% should be interpreted in relation to the clinically selected study population. All specimens were obtained from symptomatic outpatients referred for urine culture rather than from an unselected community sample. The proportion therefore represents diagnostic yield within the participating hospital and should not be interpreted as the population prevalence of urinary tract infection in Multan. The predominance of women among culture-positive patients is consistent with the established epidemiology of urinary tract infection, in which anatomical, hormonal and behavioural factors increase susceptibility among adult women (1–4).

E. coli accounted for 58.7% of all isolates and remained the principal cause of community-acquired urinary infection. Its predominance is consistent with international evidence and studies conducted in Pakistan, where uropathogenic E. coli is repeatedly identified as the leading organism in both uncomplicated and outpatient urinary tract infections (1,14–18,20). The ability of uropathogenic E. coli to adhere to the uroepithelium, evade host defences and establish reservoirs within the urinary tract contributes to its persistent epidemiological importance (1,13). Nevertheless, the proportion observed in this study should be interpreted within the specific clinical and laboratory selection criteria used at the participating hospital.

K. pneumoniae was the second most frequent Gram-negative organism and accounted for 13.0% of the isolates. Its presence is clinically important because Klebsiella species can acquire and disseminate multiple antimicrobial-resistance determinants, including genes associated with extended-spectrum beta-lactamase and carbapenemase production. Similar concerns regarding resistant K. pneumoniae and other Enterobacterales have been reported in community and outpatient populations internationally and within Pakistan (10–13,16–19). Molecular resistance mechanisms were not investigated in the present study; therefore, the observed susceptibility profiles cannot be used to infer specific resistance genes or enzyme production.

Meropenem demonstrated the highest in-vitro susceptibility among both E. coli and K. pneumoniae. This finding indicates retained microbiological activity against most isolates but does not support routine empirical carbapenem use for community-acquired urinary tract infections. Carbapenems should remain reserved for appropriately selected severe or resistant infections because unnecessary use may accelerate the emergence of carbapenem-resistant organisms. Their activity in an antibiogram must therefore be interpreted separately from their suitability as first-line outpatient treatment.

Among the tested agents that may be considered in urinary infection management, nitrofurantoin and fosfomycin showed comparatively favourable activity against E. coli, with susceptibility rates of 82.4% and 79.6%, respectively. These findings are broadly consistent with surveillance studies and treatment guidance reporting that these agents retain activity against many uncomplicated urinary isolates despite increasing resistance to several older antimicrobials (5,8,25). However, their clinical use depends on the infecting organism, infection site, renal function, patient characteristics and local prescribing guidance. The lower nitrofurantoin and fosfomycin susceptibility observed among K. pneumoniae also demonstrates that activity against E. coli should not be generalised to all urinary pathogens.

Susceptibility to ciprofloxacin, trimethoprim-sulfamethoxazole and ceftriaxone was below 50% among both major Enterobacterales. Similar patterns of reduced susceptibility to fluoroquinolones, folate-pathway inhibitors and third-generation cephalosporins have been documented in Pakistani studies (14–24). Potential contributors include frequent empirical prescribing, over-the-counter access to antimicrobials, self-medication, incomplete treatment courses and inadequate antimicrobial-stewardship implementation (19). These exposures were not measured in the present study and therefore cannot be established as causes of the observed resistance pattern. Nevertheless, the low susceptibility estimates indicate that reliance on these agents without local microbiological evidence may result in inadequate empirical coverage.

Multidrug resistance was present in 38.6% of all isolates. Half of the K. pneumoniae isolates and 36.1% of the E. coli isolates met the MDR definition. Although the MDR prevalence in K. pneumoniae was 1.38 times that in E. coli, the estimate was imprecise and the difference was not statistically significant. The wide confidence interval reflects the relatively small number of K. pneumoniae isolates and indicates that the observed difference should be interpreted as a descriptive pattern rather than definitive evidence of species-level disparity. The overall MDR burden nevertheless supports concerns that resistant urinary pathogens are established within community and outpatient populations (9–13).

The findings have practical implications for diagnostic stewardship and institutional prescribing policy. Urine culture and organism-specific susceptibility testing are particularly important for patients with recurrent symptoms, previous antimicrobial exposure, treatment failure, comorbid illness or other risk factors for resistant infection. Institutional antibiograms should distinguish organisms, antimicrobial agents and clinical settings rather than relying solely on pooled susceptibility percentages. Periodic surveillance can assist clinicians in identifying agents that retain useful activity while limiting unnecessary exposure to broad-spectrum and reserve antimicrobials.

The study provides recent organism-specific data from a clearly defined adult outpatient population and includes both antimicrobial susceptibility and MDR estimates. However, several limitations should be considered. The study was conducted at one tertiary-care hospital, limiting generalisability beyond its referral population. The available data did not allow separate reporting of specimens with no growth, insignificant growth and contamination. Previous antimicrobial use, recurrence, pregnancy, diabetes, urinary tract abnormalities and other clinical risk factors were not analysed. Susceptibility findings were presented principally for E. coli and K. pneumoniae, and complete susceptible, intermediate and resistant distributions were not available for all organisms. Phenotypic confirmation of extended-spectrum beta-lactamase production and molecular detection of resistance determinants were not performed. The cross-sectional design also precludes conclusions regarding temporal increases or causes of antimicrobial resistance.

CONCLUSION

Community-acquired urinary tract infections among adult outpatients attending the participating tertiary-care hospital were predominantly caused by E. coli, followed by K. pneumoniae and other clinically important uropathogens. Nitrofurantoin and fosfomycin retained comparatively favourable activity against E. coli, whereas susceptibility to ciprofloxacin, trimethoprim-sulfamethoxazole and ceftriaxone was limited among the major Enterobacterales. Multidrug resistance affected 38.6% of all isolates, demonstrating a substantial resistance burden within the outpatient population. These findings support organism-specific local antibiogram surveillance, appropriate urine-culture utilisation and cautious empirical antimicrobial selection based on verified institutional susceptibility patterns.

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