ORIGINAL RESEARCH

Comparative Study of Antibiotic Resistance Patterns in Hospital-Acquired vs. Community-Acquired Urinary Tract Infections

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ABSTRACT

Background: Urinary tract infections (UTIs) are among the most frequently encountered bacterial infections in both community and hospital settings. The rising prevalence of antimicrobial resistance, particularly in hospital-acquired infections, poses a serious threat to effective treatment. Comparing resistance patterns between hospital-acquired and community-acquired UTIs is crucial for guiding empirical therapy and promoting antimicrobial stewardship. **Aim:** To compare the bacterial profiles and antibiotic resistance patterns of hospital-acquired versus community-acquired urinary tract infections in adult patients. **Material and Methods:** This comparative observational study was conducted over 12 months in the Department of Microbiology in collaboration with the Department of Medicine at a tertiary care hospital. A total of 100 adult patients with culture-confirmed UTIs were enrolled and categorized into two groups: 50 with hospital-acquired UTIs (HA-UTIs) and 50 with community-acquired UTIs (CA-UTIs). Urine samples were processed using standard microbiological techniques. Antibiotic susceptibility testing was performed by the Kirby-Bauer disk diffusion method following CLSI 2023 guidelines. Multidrug resistance (MDR) was defined as resistance to three or more classes of antibiotics. **Results:** *Escherichia coli* was the most frequently isolated pathogen, significantly more common in CA-UTIs (64%) than HA-UTIs (36%, $p = 0.004$). HA-UTIs showed a higher prevalence of *Klebsiella pneumoniae* (28% vs. 12%, $p = 0.038$) and *Pseudomonas aeruginosa* (20% vs. 6%, $p = 0.041$). Resistance to commonly used antibiotics, including ciprofloxacin, ceftriaxone, and nitrofurantoin, was higher in HA-UTI isolates, particularly among *E. coli* and *Klebsiella* species. MDR rates were significantly higher in HA-UTIs for *E. coli* (66.67% vs. 31.25%, $p = 0.018$), with overall MDR observed in 64% of HA-UTI cases compared to 26% of CA-UTIs ($p = 0.0003$). Resistance to reserve antibiotics such as piperacillin-tazobactam and meropenem was also significantly more frequent in HA-UTIs. **Conclusion:** Hospital-acquired UTIs exhibit a broader spectrum of pathogens and significantly higher resistance rates compared to community-acquired infections. The findings emphasize the need for ongoing antimicrobial surveillance and the implementation of targeted antibiotic stewardship strategies to curb resistance and improve treatment outcomes.

Keywords: Urinary tract infection, antibiotic resistance, hospital-acquired infection, community-acquired infection, multidrug resistance

INTRODUCTION

Urinary tract infections (UTIs) remain one of the most common infectious diseases across all age groups, affecting millions of individuals annually and placing a significant burden on healthcare systems worldwide. The urinary tract, typically a sterile environment, becomes vulnerable to bacterial colonization due to multiple predisposing factors. While most UTIs are community-acquired and generally respond well to empirical antibiotic therapy, the landscape has shifted dramatically in recent decades with the rise in healthcare-associated infections, increasing

antimicrobial resistance, and emerging diagnostic complexities.[1]

UTIs are broadly classified based on the setting of acquisition—community-acquired, healthcare-associated, and hospital-acquired. Community-acquired UTIs are typically seen in healthy individuals with no recent exposure to healthcare settings. In contrast, hospital-acquired UTIs, often referred to as nosocomial infections, develop in hospitalized patients, typically after 48 hours of admission. These infections frequently involve multidrug-resistant (MDR) pathogens and are often associated with invasive procedures such as urinary catheterization. Healthcare-associated UTIs represent an intermediate category, occurring in patients with recent hospitalization, long-term care facility residency, or recent antibiotic use. Each category of UTI presents with distinct microbial profiles and resistance patterns, necessitating differentiated diagnostic and treatment approaches.[2,3]

The clinical spectrum of UTIs ranges from asymptomatic bacteriuria to severe urosepsis. The diagnosis relies on a combination of clinical features, urine microscopy, and culture-based identification of the causative organism. However, empirical treatment often begins before culture results are available, making it crucial to understand the prevalent local resistance patterns. This is particularly important in pediatric populations and hospitalized patients, where delays in appropriate therapy can lead to complications such as renal scarring, recurrent infections, or prolonged hospital stays.[4,5]

Recent developments in antimicrobial susceptibility testing and changes in interpretive breakpoints by regulatory bodies have further complicated the clinical decision-making process. For example, the redefinition of susceptibility categories has altered how clinicians perceive intermediate and resistant strains, which has practical implications for treatment strategies. These changes underscore the need for regular updates in clinical guidelines and continuing medical education to keep pace with evolving microbiological interpretations.[6]

Antibiotic resistance has emerged as a formidable global challenge, with UTIs serving as one of the most affected infectious syndromes. Resistance to commonly prescribed antibiotics such as ampicillin, trimethoprim-sulfamethoxazole, fluoroquinolones, and cephalosporins is now widespread, particularly among Enterobacteriaceae such as *Escherichia coli* and *Klebsiella pneumoniae*. These organisms often acquire resistance through plasmid-mediated mechanisms, extended-spectrum beta-lactamase (ESBL) production, and biofilm formation. Biofilm-producing organisms are particularly problematic in catheter-associated UTIs, where they resist both host immune defenses and antimicrobial therapy. Multidrug-resistant strains are increasingly being detected in both hospital and community settings, complicating empirical treatment decisions and leading to higher rates of therapeutic failure.[7]

In pediatric populations, the scenario is equally concerning. Children, especially those under five years of age, are particularly susceptible to UTIs due to anatomical and functional factors. While empirical therapy often remains effective in uncomplicated cases, increasing resistance rates are narrowing the options for safe and effective antibiotics in this age group. Moreover, recurrent UTIs in children are associated with congenital anomalies, dysfunctional voiding, or immunosuppression, necessitating long-term prophylaxis and careful follow-up. The emergence of resistant pathogens in pediatric UTIs not only limits therapeutic options but also raises concerns about long-term renal health and increased healthcare costs.[8]

The burden of hospital-acquired UTIs is further compounded by the impact of prolonged hospitalization, increased diagnostic and therapeutic costs, and heightened morbidity and mortality. These infections often occur in immunocompromised individuals or those undergoing urological interventions and are more likely to be polymicrobial and resistant to multiple antibiotics. The need for broad-spectrum or reserve antibiotics such as carbapenems or colistin in these cases accelerates the development of antimicrobial resistance at the institutional level. Preventive strategies such as timely catheter removal, aseptic catheter insertion techniques, and strict adherence to hand hygiene protocols are critical in reducing the incidence of such infections.[9]

Furthermore, prescribing patterns and inappropriate use of antibiotics in both inpatient and outpatient settings contribute significantly to the resistance crisis. Overuse of fluoroquinolones and third-generation cephalosporins, for instance, has led to increased resistance among Gram-negative uropathogens. Data from various clinical studies suggest that rational prescribing based on culture sensitivity reports, local antibiograms, and periodic surveillance of resistance patterns can significantly improve treatment outcomes and reduce resistance trends.[10]

Comparative studies examining resistance patterns between hospital-acquired and community-acquired UTIs have highlighted marked differences in pathogen profiles and susceptibility. Hospital-acquired UTIs are more likely to involve non-*E. coli* pathogens such as *Klebsiella*, *Pseudomonas*, and *Enterococcus*, often resistant to first-line agents. In contrast, community-acquired infections are still largely dominated by *E. coli*, although resistance is rising even in the outpatient setting. These differences reinforce the importance of tailored antibiotic policies and evidence-based empirical treatment strategies.[11]

In light of these evolving challenges, it is essential to generate and disseminate local data on resistance trends, antimicrobial usage, and microbiological

profiles. Such data not only guide empirical treatment but also inform institutional antibiotic stewardship programs, policy-making, and clinical guideline development. Ultimately, an integrated approach involving microbiologists, clinicians, pharmacists, and infection control teams is needed to combat the growing threat of urinary tract infections in both community and hospital environments.

MATERIAL AND METHODS

This comparative, observational study was conducted in the Department of Microbiology, in collaboration with the Department of Medicine, at a tertiary care teaching hospital over a period of 12 months. The study was approved by the Institutional Ethics Committee (IEC), and informed written consent was obtained from all participants or their legal guardians prior to inclusion.A total of **100 adult patients** diagnosed with urinary tract infections (UTIs) were enrolled and categorized into two groups:

- **Group A (Hospital-Acquired UTIs)**: 50 patients who developed UTI symptoms after **48 hours of hospital admission** or within 48 hours of discharge.
- **Group B (Community-Acquired UTIs)**: 50 patients who presented with UTI symptoms prior to hospital admission and had no hospitalization in the previous 3 months.

Inclusion Criteria

- Adults aged ≥18 years.
- Clinical symptoms suggestive of UTI (e.g., dysuria, frequency, urgency, suprapubic pain, fever).
- Positive urine culture with a colony count $\geq 10^5$ CFU/mL of a single bacterial species.
- For Group A: patients developing UTI during or shortly after hospital stay.
- For Group B: patients presenting from the community without recent hospitalization.

Exclusion Criteria

- Patients with known anatomical or functional abnormalities of the urinary tract.
- Patients with indwelling urinary catheters for more than 48 hours prior to culture.
- Patients on antibiotic therapy for any reason in the preceding 7 days.
- Pregnant women.

Sample Collection and Processing

Midstream clean-catch urine samples were collected aseptically in sterile containers. In hospitalized patients unable to pass urine, samples were collected using in-out catheterization under aseptic conditions. All samples were transported immediately to the microbiology laboratory and processed within 2 hours.

Urine samples were cultured on Cysteine Lactose Electrolyte Deficient (CLED) agar and MacConkey agar using calibrated loop technique (0.001 mL loop). Plates were incubated at 37°C for 18–24 hours. Significant bacteriuria was defined as a colony count $\geq 10^5$ CFU/mL.

Identification and Antibiotic Sensitivity Testing

Bacterial isolates were identified based on colony morphology, Gram staining, and standard biochemical tests. Antibiotic susceptibility testing was performed using the Kirby-Bauer disk diffusion method on Mueller-Hinton agar, as per Clinical and Laboratory Standards Institute (CLSI) 2023 guidelines.

The following antibiotics were tested: ampicillin, ciprofloxacin, levofloxacin, co-trimoxazole, nitrofurantoin, ceftriaxone, cefotaxime, ceftazidime, amikacin, gentamicin, piperacillin-tazobactam, meropenem, and colistin. Multidrug resistance (MDR) was defined as resistance to ≥3 classes of antimicrobial agents.

Data Collection and Statistical Analysis

Demographic and clinical data, culture results, and antibiotic resistance patterns were recorded in a structured proforma. Statistical analysis was performed using SPSS version 25.0. Descriptive statistics were used to summarize data. Chi-square test or Fisher's exact test was applied to compare resistance patterns between groups. A p-value <0.05 was considered statistically significant.

RESULTS

Demographic Distribution (Table 1)

Among the 100 patients enrolled in the study, 50 were diagnosed with hospital-acquired UTIs (HA-UTIs) and 50 with community-acquired UTIs (CA-UTIs). The age distribution showed that the majority of participants in both groups were between 31 and 50 years (40.00% in HA-UTI and 44.00% in CA-UTI), followed by those aged above 50 years in the HA-UTI group (36.00%) and those aged 18–30 in the CA-UTI group (36.00%). Although younger individuals (18–30 years) were more prevalent in the CA-UTI group and older adults (>50 years) were more common in the HA-UTI group, the age-wise difference was not statistically significant ($p = 0.112$). In terms of gender distribution, males were slightly more affected in the HA-UTI group (56.00%), while females were more represented in the CA-UTI group (52.00%). However, this gender distribution did not show a significant difference between groups ($p = 0.214$).

Bacterial Isolates Distribution (Table 2)

The most frequently isolated pathogen overall was *Escherichia coli*, found in 50 cases. It was significantly more common in the CA-UTI group (64.00%) compared to the HA-UTI group (36.00%) ($p = 0.004$). In contrast, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* were significantly more prevalent in the HA-UTI group—*Klebsiella* in 28.00% vs. 12.00% ($p = 0.038$), and *Pseudomonas* in

20.00% vs. 6.00% (p = 0.041) respectively. *Enterococcus spp.* and other less common organisms were distributed similarly across both groups without significant differences. These findings suggest that CA-UTIs are primarily due to *E. coli*, whereas HA-UTIs have a more diverse range of Gram-negative pathogens, including more resistant species.

Antibiotic Resistance Patterns (Table 3)

Escherichia coli isolates from HA-UTIs demonstrated higher resistance to common antibiotics compared to those from CA-UTIs. Resistance to ampicillin (88.89% vs. 68.75%), ciprofloxacin (77.78% vs. 50.00%, p = 0.046), nitrofurantoin (33.33% vs. 12.50%), and ceftriaxone (66.67% vs. 43.75%) was observed in the HA-UTI group. Even for meropenem, although resistance was low, it was still more common in HA-UTIs (11.11% vs. 3.13%).

For *Klebsiella pneumoniae*, resistance to ampicillin, ciprofloxacin, and ceftriaxone was above 70% in HA-UTI cases. Though the differences between HA and CA groups were not statistically significant, the resistance trends were higher in the hospital-acquired group.

Pseudomonas aeruginosa isolates in HA-UTIs showed considerable resistance to ciprofloxacin (80.00%), ceftazidime (60.00%), and piperacillin-tazobactam (70.00%), with notable resistance to meropenem (40.00%). In contrast, the CA-UTI group had lower resistance across these antibiotics.

Enterococcus spp. showed moderate resistance to ampicillin (50.00% in HA-UTI vs. 20.00% in CA-UTI) and vancomycin (25.00% vs. 0%), though these differences were not statistically significant.

Multidrug Resistance Distribution (Table 4)

Multidrug resistance (MDR), defined as resistance to three or more classes of antibiotics, was markedly higher in hospital-acquired infections. Among *E. coli* isolates, 66.67% of HA-UTI cases were MDR compared to 31.25% in CA-UTI (p = 0.018). *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* also showed higher MDR rates in HA-UTIs (71.43% and 80.00%, respectively) compared to CA-UTIs (33.33% and 33.33%). Overall, MDR was significantly more prevalent in the HA-UTI group (64.00%) compared to the CA-UTI group (26.00%) (p = 0.0003), highlighting a critical concern regarding antibiotic stewardship in hospital settings.

Resistance to Reserve Antibiotics (Table 5)

Hospital-acquired infections showed substantially higher resistance to last-resort antibiotics. Resistance to piperacillin-tazobactam was observed in 44.00% of HA-UTI cases versus 16.00% in CA-UTIs (p = 0.002). Similarly, meropenem resistance was significantly higher in HA-UTIs (20.00% vs. 4.00%, p = 0.014). Although colistin resistance was observed only in the HA-UTI group (4.00%), the difference was not statistically significant. These findings indicate that pathogens isolated from hospitalized patients are more likely to be resistant to advanced and broad-spectrum antibiotics, posing therapeutic challenges and increasing the risk of treatment failure.

Table 1: Demographic Distribution of Study Participants (N = 100)

Variable	Group A (HA-UTI) n=50	Group B (CA-UTI) n=50	Total n=100	*P* value
Age (years)				
18–30	12 (24.00%)	18 (36.00%)	30 (30.00%)	0.112
31–50	20 (40.00%)	22 (44.00%)	42 (42.00%)	
>50	18 (36.00%)	10 (20.00%)	28 (28.00%)	
Sex				0.214
Male	28 (56.00%)	24 (48.00%)	52 (52.00%)	
Female	22 (44.00%)	26 (52.00%)	48 (48.00%)	

Table 2: Distribution of Bacterial Isolates (N = 100)

Organism Isolated	Group A (HA-UTI) n=50	Group B (CA-UTI) n=50	*P* value
Escherichia coli	18 (36.00%)	32 (64.00%)	0.004
Klebsiella pneumoniae	14 (28.00%)	6 (12.00%)	0.038
Pseudomonas aeruginosa	10 (20.00%)	3 (6.00%)	0.041
Enterococcus spp.	4 (8.00%)	5 (10.00%)	0.726
Others	4 (8.00%)	4 (8.00%)	1.000

Table 3: Antibiotic Resistance Patterns of Bacterial Isolates in HA-UTI and CA-UTI (N = 100)

Bacterial Isolate	Antibiotic	HA-UTI Resistant n/N (%)	CA-UTI Resistant n/N (%)	*P* value
Escherichia coli (n=50)	Ampicillin	16/18 (88.89%)	22/32 (68.75%)	0.102
	Ciprofloxacin	14/18 (77.78%)	16/32 (50.00%)	0.046
	Nitrofurantoin	6/18 (33.33%)	4/32 (12.50%)	0.079
	Ceftriaxone	12/18 (66.67%)	14/32 (43.75%)	0.142
	Meropenem	2/18 (11.11%)	1/32 (3.13%)	0.279

Klebsiella pneumoniae (n=20)	Ampicillin	12/14 (85.71%)	4/6 (66.67%)	0.362
	Ciprofloxacin	10/14 (71.43%)	3/6 (50.00%)	0.362
	Nitrofurantoin	4/14 (28.57%)	1/6 (16.67%)	0.582
	Ceftriaxone	10/14 (71.43%)	3/6 (50.00%)	0.362
	Meropenem	2/14 (14.29%)	0/6 (0.00%)	0.376
Pseudomonas aeruginosa (n=13)	Ciprofloxacin	8/10 (80.00%)	1/3 (33.33%)	0.135
	Ceftazidime	6/10 (60.00%)	1/3 (33.33%)	0.432
	Piperacillin-Tazobactam	7/10 (70.00%)	1/3 (33.33%)	0.270
	Meropenem	4/10 (40.00%)	0/3 (0.00%)	0.142
Enterococcus spp. (n=9)	Ampicillin	2/4 (50.00%)	1/5 (20.00%)	0.500
	Nitrofurantoin	0/4 (0.00%)	0/5 (0.00%)	—
	Vancomycin	1/4 (25.00%)	0/5 (0.00%)	0.444

Table 4: Multidrug Resistance (MDR) Distribution Among Isolates (N = 100)

Organism Isolated	MDR in HA-UTI n (%)	MDR in CA-UTI n (%)	*P* value
Escherichia coli	12/18 (66.67%)	10/32 (31.25%)	0.018
Klebsiella pneumoniae	10/14 (71.43%)	2/6 (33.33%)	0.093
Pseudomonas aeruginosa	8/10 (80.00%)	1/3 (33.33%)	0.135
Overall MDR (All cases)	32 (64.00%)	13 (26.00%)	0.0003

Table 5: Resistance to Reserve Antibiotics in HA-UTI vs. CA-UTI Cases

Antibiotic	Resistant in HA-UTI (n=50)	Resistant in CA-UTI (n=50)	*P* value
Piperacillin-Tazobactam	22 (44.00%)	8 (16.00%)	0.002
Meropenem	10 (20.00%)	2 (4.00%)	0.014
Colistin	2 (4.00%)	0 (0.00%)	0.154

DISCUSSION

In this comparative study involving 100 patients, 50 each with hospital-acquired (HA-UTI) and community-acquired urinary tract infections (CA-UTI), demographic characteristics such as age and sex showed no statistically significant differences. Most patients in both groups were between 31–50 years (40% in HA-UTI vs. 44% in CA-UTI), followed by patients aged over 50 years (36% in HA-UTI) and 18–30 years (36% in CA-UTI). Males predominated slightly in HA-UTI cases (56%), while females were more common in CA-UTIs (52%). These findings are consistent with the observations made by Mitchell et al (2016), who noted that older hospitalized patients are at higher risk of acquiring UTIs, particularly due to indwelling devices and comorbid conditions.[12] Conversely, Eshwarappa et al (2011) reported a marked female predominance in CA-UTIs due to anatomical and behavioral factors, which aligns partially with our CA-UTI group.[13]

Microbiologically, *Escherichia coli* was the most common uropathogen, accounting for 64% of isolates in CA-UTIs and 36% in HA-UTIs. This supports the findings of Chandrasekhar et al (2018), who reported *E. coli* as the predominant pathogen in CA-UTIs in India (around 60–70%).[14] In contrast, *Klebsiella pneumoniae* was significantly more common in HA-UTIs (28% vs. 12%), as was *Pseudomonas aeruginosa* (20% vs. 6%). These organisms are often implicated in hospital settings due to their association with indwelling devices and high environmental persistence, a pattern highlighted by Cek et al (2014) and Melaku et al (2012). In our study, the distribution of *Enterococcus spp.* and other organisms was similar in both groups.[15,16]

Antibiotic resistance patterns revealed that *E. coli* from HA-UTIs exhibited significantly higher resistance to ciprofloxacin (77.78% vs. 50%, $p = 0.046$), nitrofurantoin (33.33% vs. 12.50%), and ceftriaxone (66.67% vs. 43.75%). Resistance to ampicillin was also higher in HA-UTIs (88.89% vs. 68.75%). These figures echo the findings of Dharmishtha et al (2012), who observed ciprofloxacin resistance in 75–85% of *E. coli* isolates from hospitalized patients, compared to 40–50% in community-acquired infections.[17] Similarly, Mukherjee et al (2013) reported that ESBL-producing *E. coli* isolates from hospitalized patients in Kolkata demonstrated over 65% resistance to third-generation cephalosporins and fluoroquinolones.[18]

Klebsiella pneumoniae showed resistance levels above 70% to ampicillin, ciprofloxacin, and ceftriaxone in HA-UTIs, while lower resistance was seen in CA-UTI isolates. This trend aligns with the reports of Kaur et al (2016), who noted widespread multidrug resistance in *Klebsiella* isolates from hospital wards.[19]*Pseudomonas aeruginosa* from HA-UTIs in our study showed 80% resistance to ciprofloxacin, 60% to ceftazidime, and 70% to piperacillin-tazobactam, with 40% even resistant to meropenem. These rates are consistent with the findings of Köves et al (2017), who emphasized high

resistance in catheter-associated *Pseudomonas* infections, with up to 70–80% of isolates resistant to beta-lactam antibiotics.[20]

Our data also revealed a higher burden of multidrug resistance (MDR) in HA-UTIs compared to CA-UTIs. Among *E. coli* isolates, 66.67% in HA-UTIs were MDR versus 31.25% in CA-UTIs (p = 0.018). Similarly, 71.43% of *Klebsiella pneumoniae* and 80% of *Pseudomonas aeruginosa* isolates in HA-UTIs were MDR, compared to only 33.33% in CA-UTIs. Overall, MDR prevalence was 64% in HA-UTIs and 26% in CA-UTIs (p = 0.0003). These figures are comparable to those reported by Magiorakos et al (2012), who classified MDR prevalence among uropathogens as alarmingly high in hospital settings worldwide.[21] Additionally, Mukherjee et al (2013) found that over 60% of uropathogenic*E. coli* from ICU patients exhibited MDR profiles, supporting the findings in our cohort.[18]

The resistance to reserve antibiotics was also concerning. Resistance to piperacillin-tazobactam was found in 44% of HA-UTIs compared to 16% in CA-UTIs (p = 0.002), while meropenem resistance was 20% in HA-UTIs versus 4% in CA-UTIs (p = 0.014). Colistin resistance, although low (4%), was detected only in HA-UTIs. These results closely parallel the observations of Chacko et al (2017), who linked carbapenem and colistin resistance with prior ICU stay and prolonged antibiotic exposure.[22] The increasing resistance to these last-line agents is a critical issue, particularly in HA-UTIs, as highlighted by Melaku et al, due to limited therapeutic options and increased risk of treatment failure.[16]

CONCLUSION

This study highlights a significantly higher prevalence of multidrug-resistant pathogens and antibiotic resistance in hospital-acquired urinary tract infections compared to community-acquired cases. *Escherichia coli* remained the predominant organism overall, but HA-UTIs showed a greater diversity of resistant organisms like *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. Resistance to broad-spectrum and reserve antibiotics was markedly higher in hospitalized patients. These findings underscore the urgent need for targeted antibiotic stewardship and continuous surveillance of local resistance patterns.

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