ORIGINAL ARTICLE

Prevalence and Antimicrobial Susceptibility Pattern of Bacterial Isolated from Urine Culture in Patient with Acute Uncomplicated Cystitis in Vajira Hospital

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Objective: To determine the prevalence and antimicrobial susceptibility pattern of bacteria isolated from urine culture in patients with acute uncomplicated cystitis in Vajira Hospital.

Materials and Methods: The cross-sectional study included 351 cases of acute uncomplicated cystitis between December 1, 2020, and December 31, 2021, at Vajira Hospital. All parameters and laboratory results were collected from the medical records.

Results: *Escherichia coli* was the most prevalent pathogen at 49.9%, followed by *Klebsiella pneumoniae* at 7.1% and *Proteus mirabilis* at 3.4%. Other identified pathogens included *Staphylococcus saprophyticus* at 1.7%, *Streptococcus agalactiae* at 1.4%, *Corynebacterium* at 1.2%, and miscellaneous others at 4%. Cephalosporins, with 52.7%, and fluoroquinolones, with 23.8%, were the most common treatments. Amoxicillin or clavulanic acid was the third most prescribed antibiotic at 10.8%, followed by fosfomycin at 8.0%, ertapenem at 2.0%, and trimethoprim/sulfamethoxazole (TMP/SMX) at 1.4%. Notably, *E. coli* exhibited high resistance to ampicillin for 73.1%, ciprofloxacin for 69.7%, TMP/SMX for 54.9%, and ceftriaxone for 30.3%. *K. pneumoniae* showed significant resistance to ampicillin for 88%, ciprofloxacin for 72%, and TMP/SMX for 40%). *P. mirabilis* demonstrated notable resistance to TMP/SMX for 58.3% and ciprofloxacin for 41.7%.

Conclusion: *E. coli*, *K. pneumoniae*, and *P. mirabilis* are the common pathogens in acute uncomplicated cystitis at Vajira Hospital. Given their high resistance to fluoroquinolones and TMP/SMX, alternative treatment options should be considered to address antimicrobial resistance effectively.

Keywords: Cystitis; Urinary tract infections; Drug susceptibility; Drug resistance

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Acute cystitis predominantly affects women and poses a significant public health challenge globally. Approximately 50% of women are estimated to experience this condition at least once in their lifetime, with nearly one-third of cases occurring before or by the age of 24[1]. Apart from its adverse effects on individual quality of life, acute cystitis also imposes substantial burdens on healthcare systems[1-3].

The causative agents of urinary tract infections (UTIs) vary across different geographical locations. A wide range of antibiotics have been developed to address these infections. This diversity in pathogens results in variations in the approach to and treatment of UTIs. However, it is currently noted that the evolution of diseases has led to the emergence of drug-resistant strains. Improper or inadequate antibiotic management has been identified as a contributing factor to the growing prevalence of antibiotic-resistant strains[3-24].

Research on the evolution of pathogen resistance to antibiotics indicates a significant rise in drug-resistant strains across various regions of Thailand[25-29]. These studies demonstrate an annual increase in the percentage of drug-resistant strains for each type of pathogen. Typically, laboratory results for antimicrobial susceptibility testing are available within two to three days after sample collection, guiding empirical treatment decisions based on the expected spectrum of causative microorganisms and data on antibiotic resistance from previous infections[30].

The present study aimed to investigate the prevalence of bacteria responsible for acute uncomplicated cystitis, defined as a UTI occurring

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in otherwise healthy women, free from any underlying urinary tract abnormalities or complicating factors such as pregnancy or immunosuppression. Additionally, participants in the present study had no history of using medical devices or undergoing procedures related to the urinary system. The study would also assess the antibiotic resistance and susceptibility of the identified pathogens. Furthermore, the authors seek to explore the relationship between the administration of antibiotics, susceptibility test results, and treatment outcomes at Vajira Hospital. Enhanced knowledge of local etiologic agents of UTIs and their resistance patterns to antibiotics would provide guidance for clinicians in making empirical treatment decisions.

Materials and Methods

The present study was a cross-sectional study conducted at Vajira Hospital between December 1, 2020, and December 31, 2021. Three hundred fifty-one patients diagnosed with acute uncomplicated cystitis were included. The inclusion criteria comprised of female patients aged 18 years and above diagnosed with acute uncomplicated cystitis, receiving treatment at the outpatient department (OPD) of Vajira Hospital, and undergoing urine culture examination. The exclusion criteria included patients declining participation, those with incomplete medical records, pregnant patients, those with immunodeficiency or taking immunomodulatory medications, patients with known urinary system structural abnormalities or dysfunction, individuals with recurrent UTIs of twice within six months or three times within the past year, recent urinary catheterization within the past two weeks, recent antibiotic treatment within the past two weeks, and hospital admission within the last month.

The investigation and management of acute uncomplicated cystitis at Vajira Hospital were based on clinical assessment, supported by urinalysis and urine culture for microbiological confirmation. Empirical antibiotic therapy was initiated at the discretion of the attending physicians, guided by clinical evaluation and local antimicrobial susceptibility patterns. Patients were routinely scheduled for follow-up within one week to review culture results and clinical response and were advised to return earlier if symptoms persisted or worsened.

The data, including demographics, medical and hospitalization history, records of urinary catheterization and antibiotic treatment, antibiotic prescribing for the treatment of cystitis, urine analysis, culture, and antibiotic susceptibility results, were collected from medical records using a case record form. Antimicrobial susceptibility testing was conducted in accordance with the established protocols outlined by the Clinical and Laboratory Standards Institute (CLSI) using the Kirby-Bauer disc diffusion method[31].

The clinical characteristics data presented continuous variables as either mean ± standard deviation or median (minimum to maximum), depending on the data distribution. Categorical variables were expressed as frequencies and percentages. The present study received approval from the Institutional Review Board (IRB) of Vajira Hospital (COA 199/2563).

Table 1. Bacterial isolates identified in urine cultures

Bacterial isolate	Frequency; n (%)	Gram type
Escherichia coli	175 (49.9)	Gram-negative
Klebsiella pneumoniae	25 (7.1)	
Proteus mirabilis	12 (3.4)	
Staphylococcus saprophyticus	6 (1.7)	Gram-positive
Streptococcus agalactiae	5 (1.4)	
Corynebacterium spp.	4 (1.2)	
Other microorganism	14 (4.0)	
Mixed bacterial growth	52 (14.8)	
No growth	58 (16.5)	

Results

Three hundred fifty-one patients diagnosed with acute uncomplicated cystitis were enrolled for this study. The mean age of the study population was 60.2 years, with a standard deviation of 19.4. Among these patients, 247 individuals, accounting for 70.4% of the population, had underlying medical conditions. The most prevalent underlying medical conditions were hypertension at 37.61%, followed by hyperlipidemia at 25.4%, diabetes mellitus at 19.1%, gynecological cancer at 5.41%, chronic kidney disease at 4%, thyroid disorders at 3.7%, and coronary disease at 2%.

Regarding urine culture results, *Escherichia coli* was identified as the predominant pathogen in 49.9%, followed by *Klebsiella pneumoniae* in 7.1%, *Proteus mirabilis* in 3.4%, and *Staphylococcus saprophyticus* in 1.7%. *Streptococcus agalactiae* and *Corynebacterium* accounted for 1.4% and 1.2%, respectively. Miscellaneous pathogens constituted 4.0% of cases. Additionally, mixed bacterial growth was observed in 14.8% of cases, while 16.5% showed no growth (Table 1).

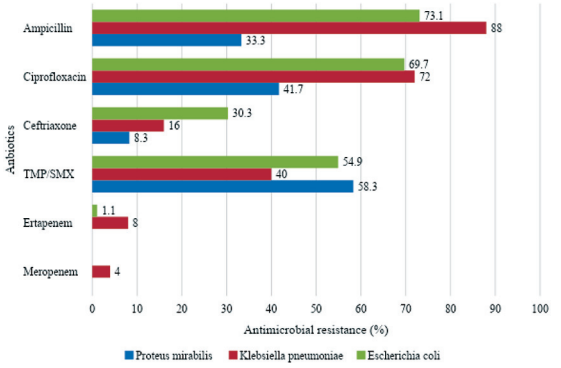

Figure 1. Antibiotic resistance rates among bacterial isolates.

Antibiotic susceptibility analysis revealed the following resistance rates. *E. coli* showed resistance rates of 73.1% to ampicillin, 69.7% to ciprofloxacin, 30.3% to ceftriaxone, 54.9% to trimethoprim/sulfamethoxazole (TMP/SMX), and 1.1% to ertapenem. *K. pneumoniae* exhibited resistance rates of 88% to ampicillin, 72% to ciprofloxacin, 16% to ceftriaxone, 40% to TMP/SMX, 8% to ertapenem, and 4% to meropenem. For *P. mirabilis*, resistance rates were 33.3% to ampicillin, 41.7% to ciprofloxacin, 8.3% to ceftriaxone, and 58.3% to TMP/SMX (Figure 1).

In the management of acute uncomplicated cystitis at Vajira Hospital, antibiotics were prescribed. The most commonly prescribed group was cephalosporins, constituting 52.7% of prescriptions. Within this group, cefixime accounted for 26.5%, ceftriaxone for 10.5%, cefditoren for 9.4%, and cefdinir for 6.3%. Following cephalosporins, fluoroquinolones were prescribed at a rate of 23.8%, with ciprofloxacin being the most frequently prescribed at 19.9%, followed by ofloxacin at 2.8%, and levofloxacin at 1.1%. Amoxicillin/clavulanic acid was the third most prescribed antibiotic at 10.8%, followed by fosfomycin at 8.0%, ertapenem at 2.0%, and TMP/SMX at 1.4% (Figure 2).

Resistance rates were high for *E. coli*, *K. pneumoniae*, and *P. mirabilis*, with notable percentages resistant to various antibiotics. *E. coli* demonstrated resistance rates of 73.1% to ampicillin, 69.7% to ciprofloxacin, and 54.9% to TMP/SMX. Similarly, *K. pneumoniae* showed resistance rates of 88% to ampicillin, 72% to ciprofloxacin, and 40% to TMP/SMX. *P. mirabilis* exhibited significant resistance to TMP/SMX at 58.3%, and ciprofloxacin at 41.7%. Cephalosporin was the most prescribed antibiotic across all pathogens, accounting for 56.6% of prescriptions for *E. coli*, 68% for *K. pneumoniae*, and 75% for *P. mirabilis*. Notably, ciprofloxacin was also commonly prescribed, constituting 16.6% of prescriptions for *E. coli*, 16% for *K. pneumoniae*, and 16.7% for *P. mirabilis* (Figure 3).

From the present study, it was noteworthy that the top three pathogens responsible for acute uncomplicated cystitis demonstrated high rates of resistance to ciprofloxacin. Nonetheless, despite these high resistance rates, ciprofloxacin remained the second most commonly prescribed therapeutic agent within the observed population.

In the authors' investigation of the outcomes of antibiotic-resistant UTI treatments involving these pathogens, the study focused on individuals who received antibiotics that were ineffective against the pathogens causing their UTIs. Among the initial population, 47% were lost to follow-up. Of the remaining 53% who were followed up, 37.1% showed resolution of symptoms characterized by the absence of UTI symptoms and the absence of white blood cells in urine analysis, while 62.9% did not show resolution

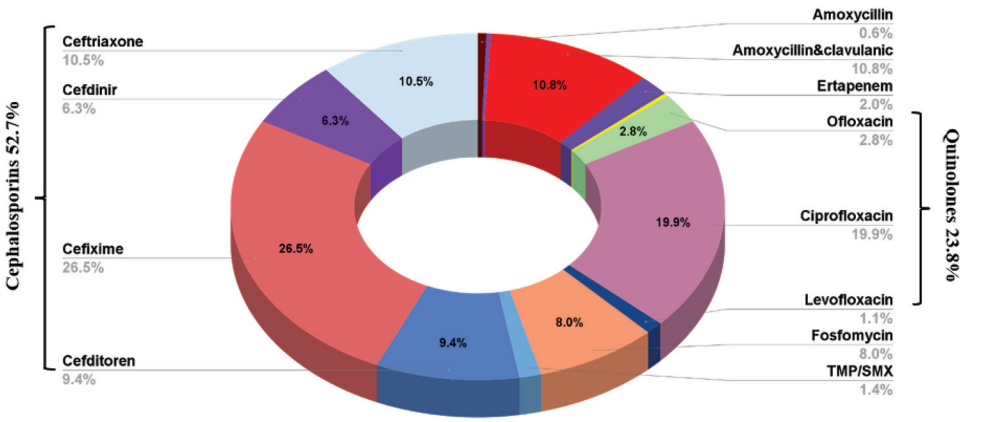

Figure 2. Distribution of antibiotic usage for the management of acute uncomplicated cystitis.

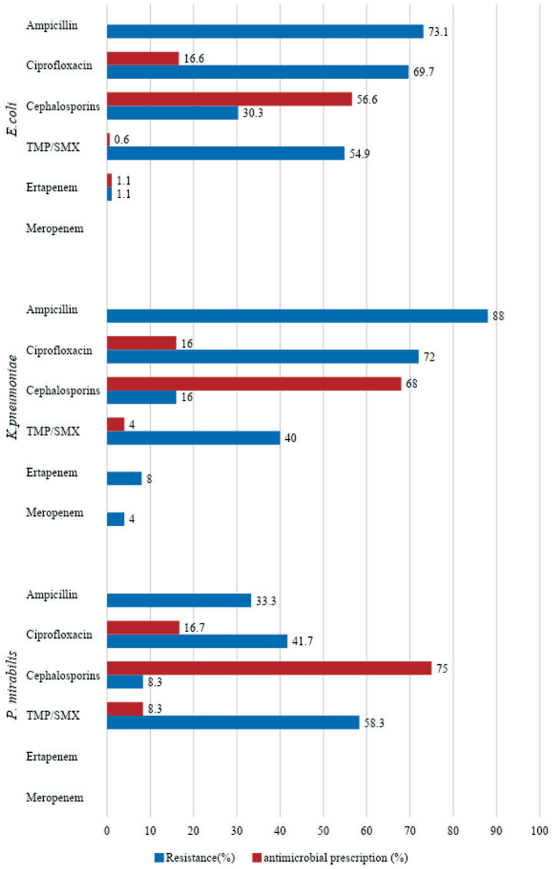

Figure 3. The relationship between antimicrobial prescriptions and bacterial resistance.

despite antibiotic treatment.

Discussion

In the present study, the etiology of acute uncomplicated cystitis predominantly implicated *E. coli* at 49.9% and *K. pneumoniae* at 7.1%. These findings were consistent with the previous studies[32-34] and were corroborated by a study conducted by Sangsuwan et al.[35] in Thailand, which was conducted at Songklanagarind. However, a study by Punakabutra et al.[36] at King Chulalongkorn Memorial Hospital reported a different pattern, with *E. coli* being the most prevalent, followed by Enterococci, and then *K. pneumoniae*. Nonetheless, in conclusion, *E. coli* remains the most common pathogen across various studies.

According to the National Antimicrobial Resistance Surveillance Center in Thailand in 2020[37], *E. coli* urinary isolates from outpatients exhibited susceptibility rates of 34.4% to ciprofloxacin, 43.3% to TMP/SMX, and 60.2% to ceftriaxone. These findings suggest that the resistance levels to quinolones, TMP/SMX, and cephalosporins were similar to those observed in the present study. Moreover, the center reported that *K. pneumoniae* isolated from OPD settings were susceptible to ciprofloxacin at a rate of 62.3%, TMP/SMX at a rate of 69.3%, and to ceftriaxone at a rate of 72.4%. This indicates that the resistance observed in the present study was higher for ciprofloxacin and TMP/SMX, but lower for ceftriaxone compared to the national surveillance data.

The clinical practice guidelines (CPG) issued by the Infectious Disease Society of America (IDSA) in 2011 advised empirical antimicrobial therapy for acute uncomplicated cystitis and pyelonephritis in women. The recommended treatment options included nitrofurantoin, TMP-SMX, fosfomycin, and fluoroquinolones. In cases where the aforementioned agents cannot be utilized, β-lactam agents were considered suitable alternatives for therapy[38].

However, in the present study, the prevalence of fluoroquinolone-resistant and TMP-SMX-resistant *E. coli*, the most common pathogen, exceeded 50%, consistent with findings from other reports[39,40]. In contrast, the susceptibility of urinary *E. coli* isolates to nitrofurantoin and fosfomycin was reported to be greater than 90% in Thailand[37,39]. Despite this, the present study revealed a different trend in antibiotic usage, with cephalosporins being the most frequently prescribed, followed by fluoroquinolones. This variation in prescribing practices among clinicians underscores the need for tailored CPG for antibiotic treatment of lower UTIs in adult females at Vajira Hospital, leveraging epidemiological data from the present study.

The present study has limitations. Firstly, the bacterial susceptibility testing conducted lacked inclusion for certain antibiotics, such as nitrofurantoin, aminoglycosides, and Fosfomycin. Consequently, the effectiveness of these drugs within the patient population at Vajira Hospital remains uncertain. Secondly, due to the cross-sectional nature of the present study, some individuals were lost to follow-up, resulting in incomplete data on treatment outcomes. Moving forward, it would be beneficial to expand the range of antibiotics included in susceptibility testing and to implement more robust follow-up mechanisms to comprehensively assess treatment efficacy. Additionally, developing clinical guidelines based on these findings in future research could aid in optimizing treatment strategies. These guidelines should also include provisions

for monitoring treatment outcomes to ensure effectiveness.

Conclusion

At Vajira Hospital, *E. coli*, *K. pneumoniae*, and *P. mirabilis* are the predominant pathogens associated with acute uncomplicated cystitis. There is a concerning trend of high resistance rates to fluoroquinolones and TMP/SMX observed among these pathogens. Thus, the utilization of these antibiotics may not be advisable given the substantial prevalence of drug resistance.

What is already known about this topic?

Acute cystitis is a common UTI that primarily affects women and poses a global public health challenge. The causative pathogens vary by region, and the emergence of drug-resistant strains has become a growing concern. Inappropriate antibiotic use is a key factor contributing to rising antimicrobial resistance.

What does this study add?

This study identifies *E. coli*, *K. pneumoniae*, and *P. mirabilis* as key pathogens in acute uncomplicated cystitis at Vajira Hospital, with high resistance to fluoroquinolones and TMP/SMX, questioning their suitability for empirical treatment.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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