

PREVALENCE AND ANTIMICROBIAL RESISTANCE PATTERN OF ESCHERICHIA COLI CAUSING URINARY TRACT INFECTIONS (UTI) AMONG PATIENTS

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ABSTRACT

Background: One of the most commonly encountered infections are UTIs, which are infections of the urinary tract that cause more than 150 million cases every year. Moreover, the main pathogen responsible for these UTI remains to be the bacteria *Escherichia coli* (*E. coli*). *E. coli* accounts for a whopping 75-90% of all UTIs because it is present in the normal flora of the gut. The risk factors for developing UTI from *E. coli* include diabetes, anal sex, blockage of the urinary tract, hormonal changes such as in pregnancy, female anatomical reasons etc.

Objective: To identify the prevalence and antimicrobial resistance pattern of *E. coli* which is isolated from urinary tract infection patients admitted in Sheikh Zayed Hospital, Lahore.

Methods: It is an observational study conducted over a period of 6 months between January to June 2025. In total 224 midstream urine samples were collected and processed through standard microbiological techniques. Firstly, urine cultures were done to isolate *E. coli* after which biochemical tests were done to confirm the diagnosis. Next, multiple antibiotics were tested using Kirby-Bauer disc diffusion protocol. The guidelines were followed according to CLSI. Qualitative data was analyzed using SPSS version 26 and presented as frequency and percentages. Chi-square test was performed to test the association between gender and prevalence of UTI.

Results: From 224 urine samples, females (57%) were more frequently affected compared to males (43%), with the most infections observed in the age group of 40–65 years. Most commonly isolated pathogen was *E. coli* 75 (34%). *E. coli* isolates exhibited greatest susceptibility to Amikacin (94%), Imipenem (93%), Meropenem (92%), urinary antiseptics Nitrofurantoin and Fosfomycin (82%) and (81%), and Gentamicin (72%). Highest rates of resistance were seen among Ciprofloxacin (18%) and Levofloxacin (14%). Furthermore, a significant association was found between gender being female and UTI occurrence (p -value < 0.05).

Conclusion: The results indicate a greater prevalence of UTI especially in female patients. The most commonly isolated pathogen remains to be *E. coli*. Aminoglycosides, Carbapenems are taken as last resort drugs; however, urinary antiseptics still are considered as the mainstay of treatment against uropathogenic *E. coli*. Drugs such as Ciprofloxacin should be avoided due to high rates of resistance. Important to note that it is extremely important to undergo routine culture and sensitivity testing before commencing antibiotic therapy.

Keywords: *E. coli*, Antimicrobial Resistance, UPEC, UTI, Carbapenems.

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INTRODUCTION

UTIs or infections of the urinary tract are the one of the most common infections seen in medical practice. Having a UTI is the second top reason to start empirical antibiotic therapy, just after community-acquired pneumonia. It is also the most common healthcare-associated infection.¹ Urinary tract infections can be caused by bacteria that live, thrive, and spread in the

urinary system. Normal flora from the gastrointestinal tract typically climb into the urethra and start to multiply, these bacteria can also undergo ascension up into the bladder; resulting in an infected urinary tract. UTIs, which account for around 35% of nosocomial or hospital-acquired infections, take second place in leading to sepsis in hospitalized patients just after respiratory tract infections.² To put it simply, UTIs can be classified in two categories: complicated UTIs and uncomplicated UTIs. The complicated UTI is defined as pyelonephritis and or cystitis that occurs in individuals with pre-existing anatomic, functional or metabolic pathologies that make UTI management very complicated. Complicated UTI often occur in hospital settings such as CAUTI (Catheter-associated UTI).³ Catheter-associated UTI is undoubtedly increases patient morbidity/mortality, and is one of the leading causes of secondary bacteremia or infections spreading to the bloodstream. Risk factors for CAUTI include: female anatomy, indwelling catheters for prolonged periods, elderly patients and diabetics.⁴ Gram-negative bacilli such as E.coli, Enterobacter, Klebsiella, and Proteus, as well as Gram-positive bacteria such as Enterococcus and Staphylococcus, can all cause UTIs. The most frequent organism responsible for nosocomial and community-acquired UTIs is E.coli.⁵ Escherichia coli, a facultative anaerobic gram negative bacilli, belongs to the family Enterobacteriaceae, mostly found in colon.⁶ E. coli is responsible for 50–60% of recurring or complicated infections and 70–90% of uncomplicated infections.⁷ The most prevalent strains of UPEC (Uropathogenic Escherichia coli) are responsible for 50% of hospital-acquired UTIs, 95% of community-acquired UTIs, and roughly 80% of all UTIs. The most frequently isolated pathogen in complicated UTIs is still UPEC.⁸ Many times, antibiotic empirical therapy is provided without conducting antibiotic susceptibility testing, which leads to the development of antimicrobial resistance which is seen in the form of multi-drug resistant (MDR) bacteria. This ultimately results in an ineffective treatment for UTI.⁸ Chronic kidney disease is a major risk factor for the development of UTIs due to metabolic disorders affecting many components of the immunity. Moreover, in patients with chronic kidney disease, UTI can occur frequently after kidney transplantation.⁹ In order to treat UTI, various antibiotics have been recommended by international guidelines, most commonly including: Nitrofurantoin Monohydrate, Trimethoprim- Sulfamethoxazole, Fluoroquinolones, and Beta-Lactams.¹¹ Unfortunately, antibiotic resistance is increasing in UTI-causing pathogens, including extended-spectrum beta-lactamase (ESBL) producing Enterobacteriaceae, such as ESBL E.coli. This is a result of the careless and extensive use of antibiotics. ESBL bacteria are resistant to the majority of the beta-lactam antibiotics, with the exception of the Carbapenems, and

are rapidly spreading in the population.¹² The purpose of this study is to study the prevalence and the pattern of antibiotic resistance in E.coli isolated from urine samples of UTI patients admitted at Shaikh Zayed Hospital, Lahore.

METHODS

The study is a cross-sectional study carried out from January to June 2025 at Department of Microbiology, Virology, and Immunology, Shaikh Zayed Hospital, Lahore. A sample size of 224 patients was calculated by using 95% Confidence level with 5% Margin of error. The urine samples were collected in sterile urine containers containing boric acid. Patients with pre-existing history of other infectious disease such as HIV were excluded, all other samples were kept. Urine samples were analyzed within 4 hours of their collection. First, wet mount microscopy was done of each urine sample to rule out candida, yeast and to enumerate the pus cells in each sample. Next, urine culture was done using sterile 10µl wire loop and samples were cultured on CLED agar with Andrade's indicator. The plates were kept in incubator overnight at 37°C. On second day the bench was done of the plates, first colony count was measured, if count was greater than 10^5 then growth was considered significant. Next the bacterial identification was confirmed using colony morphology, bench tests such as Catalase, Oxidase, and Gram staining were done to ensure gram negative rods. After that, API 20E kits were used for biochemical testing for species confirmation, and Kirby Bauer disc diffusion method was done on Mueller Hinton Agar to test the antibiotic susceptibility. The antibiotic containing plates were then incubated overnight at 37°C, results were read and recorded the next day. On the third day the zone diameters of inhibition were measured using ruler and were interpreted according to Clinical Laboratory Standard Institute (CLSI) guidelines. Antibiotics tested were Nitrofurantoin, Fosfomycin, Trimethoprim-sulfamethoxazole, Piperacillin-Tazobactam Amoxicillin-Clavulanic Acid, Amikacin, Gentamicin, Ciprofloxacin, Levofloxacin, Ceftriaxone, Cefotaxime, Meropenem, Imipenem. Multi-drug resistance (MDR) was considered when bacterial isolates were resistant to three or more antibiotics. Descriptive statistics were reported as frequency, percentages, and means when applicable along with standard deviation. For testing the association between gender and UTI occurrence, Pearson's chi square test was used and p value < 0.05 was considered as statistically significant.

RESULTS

Out of 224 patients included in this study who were admitted for UTI, 127 (57%) were female and the remaining 97 (43%) were male. E. coli was isolated in

75 out of 224 samples (33%), of which 52 (23%) were male and 23 (10%) were female (Table 1). The mean age of all the patients was 43.48 (SD 20.35). Other bacteria isolated were Klebsiella, Proteus, Pseudomonas, Enterococcus and Staphylococcus saprophyticus, in that order respectively (Figure 1). With regards to the antibiotic susceptibility pattern of E.coli, Amikacin was the most sensitive drug at 94%, followed by Imipenem, Meropenem at 93% and 92%, then Nitrofurantoin and Fosfomycin at 82% and 81%, and lastly Gentamicin at 72%. The most resistant drugs were Ciprofloxacin and Levofloxacin having susceptibility of only 18% and 14%; combination Penicillins such as Piperacillin-Tazobactam and Amoxicillin-Clavulanic Acid had 48% and 19% susceptibility. Trimethoprim-sulfamethoxazole was only 26% susceptible, and lastly Ceftriaxone and Cefotaxime were only 32% and 22% susceptible. (Table 2) Moreover, to test the association between gender and UTI occurrence the Pearson's chi-square test was used with confidence interval of 95% and alpha value of 5%. The p value was found to be <0.05, meaning that there was an increased risk of UTI occurrence among female gender, as can be seen with our results.

Table 1: Pathogen & Gender Cross-tabulation

Gender	Pathogen			Total
	E.coli	Other bacteria	No Growth	
Female	52	58	17	127
Male	23	58	16	97
Total	75	116	33	224

Table 2: Percentage of antibiotic susceptibility of E.coli

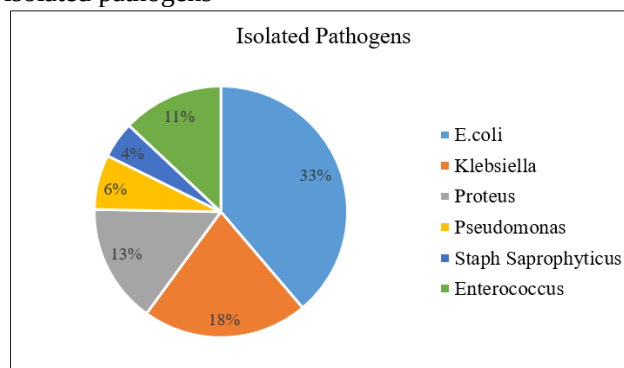
Antibiotic	% Susceptible
Amikacin	94%
Imipenem	93%
Meropenem	92%
Nitrofurantoin	82%
Fosfomycin	81%
Gentamicin	72%
Piperacillin-Tazobactam	48%
Ceftriaxone	32%
Trimethoprim-sulfamethoxazole	26%
Cefotaxime	22%
Amoxicillin-Clavulanic Acid	19%
Ciprofloxacin	18%
Levofloxacin	14%

DISCUSSION

To highlight the key findings of this study, 57% of UTI cases were from female patients and the remaining 33% were from male patients, this data was considered statistically significant with p value<0.05. The most frequently isolated pathogen in urine was E.coli, after

which Klebsiella, Proteus and other bacteria were isolated. Rates of resistance in E.coli were highest among Fluoroquinolones and Cephalosporins; whereas Aminoglycosides, Carbapenems and urinary antiseptics showed least resistance. It is important to understand that infections of the urinary tract are becoming a major source of community acquired and hospitals acquired bacterial infections. The Microbiology lab plays a vital role in the identification of the pathogens responsible for UTIs. However, it should be noted that the proper isolation and identification of the bacteria should be done as quickly as possible, as delayed diagnosis can lead to wrong usage of antibiotics which incomplete clearance of the pathogen leading to severe complications such as urosepsis as well as an increased risk of drug resistance in the bacteria. The current study was conducted to assess the prevalence of E.coli causing urinary tract infection and its association with gender. In the present study out of 224 urine samples, E.coli was found in 33% of the urine samples, being the most frequently and commonly isolated bacteria. On a similar note, an African study done by Girma et al. in 2022 found that E.coli was the most commonly isolated bacteria among UTI patients.¹³

Figure 1: Pie Chart representing frequency of different isolated pathogens



In this study, the prevalence of UTI in females (57%) was higher than that in males (33%). This finding correlates to a study done by Larkin et al. in 2025 which identified that most cases of UTI were reported among the age group 40-65 followed by 36-50 years, 20-35years, >66 years and least cases were reported below the age of 20 years.⁸ Furthermore, the antimicrobial resistance pattern seen in this study showed highest rates of resistance to Fluoroquinolones and Cephalosporins, with relatively good rates of sensitivity to Aminoglycosides and Carbapenems. This finding is in corroboration with other studies such as research done by McCowan et al. from their article published in 2022 which suggests that certain antibiotics such as are Fluoroquinolones may no longer be reliable for empirical treatment of UTIs caused by E.coli.¹ Moreover, urinary antiseptics (Nitrofurantoin, Fosfomycin), Aminoglycosides (Amikacin, Gentamicin)

and Carbapenems (Imipenem, Meropenem) still remain the drug of choice but should be used judiciously in order to prevent future resistance. This study provided a glimpse of the antibiotic sensitivity pattern and prevalence of uropathogenic E.coli seen over a cross-section of time at a tertiary care hospital in Lahore. Furthermore, this study can be improved by taking a larger cross-section of time which will provide further insight into the exact situation at hand. This data is of the utmost importance not only for microbiologists but also for clinicians that require knowledge regarding the latest antimicrobial resistance patterns of the pathogens in question in order to promote antimicrobial stewardship and better patient outcomes.

LIMITATIONS

Some limitations of this study include a small cross-section of time; data gathered over a longer period of time would have resulted in a larger sample size and a clearer image of the exact prevalence of E.coli in UTI patients and the rate of antimicrobial resistance. Moreover, further specific drug resistance mechanisms should be researched in future studies such as production of ESBL, AmpC etc. This will give an even better idea as to which antibiotics should be avoided in the patient population.

CONCLUSION

The study shows a high prevalence of UTI especially among female population. The most commonly isolated pathogen remains to be E.coli, after which Klebsiella and other such gram negative bacilli are followed. In terms of antibiotic treatment, Aminoglycosides, Carbapenems and urinary antiseptics remain the most effective treatment option against resistant uropathogenic E.coli strains. Evidently, owing to the increased antimicrobial resistance, routine culture and sensitivity testing must be performed before beginning antibiotic therapy.

ETHICAL APPROVAL

Ethical approval was granted by the TERC (Technical and Ethical Review Committee) from Shaikh Zayed Hospital's National Healthcare Research Complex vide letter Ref. No.02-TERC/NHRC-SZH/Int-SB/613. dated 31-12-2024

AUTHOR'S CONTRIBUTIONS

SM, AHB: Conceived the idea, designed, data collection, data analysis, manuscript writing

MSH: Data analysis, literature review, manuscript writing.

QA, FS: Data collection, data analysis, manuscript writing

AS: Literature review, Manuscript writing

All Authors: Approval of the final version of the manuscript to be published

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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