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Prevalence and Bacterial Profile of Urinary Tract Infections: A Cross-Sectional Study from a Tertiary Care Hospital in Pakistan

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Abstract

Background: Urinary tract infections (UTIs) are among the most common bacterial infections worldwide and pose a significant public health challenge. Globally, around 6 million patients attend outpatient clinics and approximately 300,000 are hospitalized annually due to UTIs.

Objective: The objective of this study was to determine the prevalence and distribution of bacterial pathogens associated with urinary tract infections in patients presenting to a tertiary care hospital in Pakistan.

Methodology: This descriptive cross-sectional study was conducted in the Department of Medicine, Saidu Group of Teaching Hospital, Swat, between February 1, 2022, and January 31, 2023. A total of 1000 patients aged 15–70 years with clinical symptoms of UTIs were included, while those with recent urological procedures, recurrent sexually transmitted infections, recent antibiotic use, or age above 70 years were excluded. Mid-stream urine samples were collected, cultured, and analyzed for bacterial growth and antibiotic susceptibility.

Results: Out of 1000 patients, 725 (72.5%) were female and 275 (27.5%) were male, with a mean age of 35 ± 4.5 years. Bacterial growth was detected in 831 (83.1%) samples, while 169 (16.9%) showed no growth. Escherichia coli was the predominant organism, isolated from 704 (70.4%) samples, followed by Klebsiella species (4.0%), Proteus species (1.9%), Pseudomonas aeruginosa (1.8%), Enterococcus species (1.7%), Citrobacter species (1.7%), and Staphylococcus species (1.6%). A statistically significant association was found between bacterial isolates and patient gender (p=0.0423).

Conclusion: The findings reveal Escherichia coli as the most prevalent uropathogen, emphasizing its critical role in UTIs across age groups and genders. Timely identification and targeted treatment may improve patient outcomes and help reduce long-term complications.

Keywords: Antimicrobial susceptibility, Bacterial prevalence, Escherichia coli, Urinary tract infection, Uropathogens.

Introduction

Urinary tract infections (UTIs) are highly prevalent worldwide and are recognized as a significant public health concern [1]. Approximately 6 million patients seek outpatient care annually for UTIs, and around 300,000 require hospitalization [2]. UTIs can affect both sexes and all age groups; however, females are disproportionately affected due to anatomical and physiological predispositions, such as a shorter urethra, proximity to the anal opening, pregnancy, and sexual activity [3,4].

A wide variety of pathogens are implicated in UTIs, but bacterial causes are the most dominant, accounting for the majority of cases globally [5]. UTIs are classified into febrile upper urinary tract infections (pyelonephritis), lower urinary tract infections (cystitis), and asymptomatic bacteriuria [6]. Exogenous factors, including catheterization and cystocentesis, may also introduce pathogenic bacteria, contributing to nosocomial infections [7].

It is estimated that nearly 50% of women experience at least one episode of UTI in their lifetime, with the highest incidence among individuals aged 16–64 years [8]. Gram-negative bacteria, particularly Escherichia coli and other Enterobacteriaceae, are the leading causes of UTIs, contributing to 75–95% of bacterial cases [8,9]. Other uropathogens include Klebsiella, Proteus, Enterobacter, Pseudomonas, Serratia, Staphylococcus aureus, and Enterococcus faecalis [8,9].

In developed countries such as the USA and those in Europe, UTIs account for millions of physician referrals annually. For instance, approximately 7 million UTI patients are referred in the USA each year, with UTIs responsible for nearly 15% of antibiotic prescriptions and representing about 0.7% of all outpatient services [10]. Effective management of UTIs requires accurate identification of the causative pathogens and their antimicrobial resistance profiles to ensure optimal therapeutic strategies [11].
Given the high burden of UTIs and the critical role of bacterial pathogens, this study was conducted to determine the prevalence and distribution of uropathogens in patients presenting to a tertiary care hospital in Pakistan. Understanding the local bacterial profile and its variations with gender and age can guide clinicians in early diagnosis and effective treatment, ultimately reducing disease burden and complications.

Methodology

Study Design:

This research was conducted as a descriptive cross-sectional study to determine the most prevalent bacterial pathogens responsible for urinary tract infections (UTIs). The study design allowed for the collection and analysis of data from patients over a fixed period, enabling a comprehensive snapshot of the bacterial profile among the study population.

Ethics:

The study was approved by the Ethical Review Board of Saidu Medical College/Saidu Group of Teaching Hospital, Swat (Approval No. 57-ERB/024). Written informed consent was obtained from all participants prior to enrollment, and confidentiality of patient information was strictly maintained throughout the study.

Setting

The study was carried out in the Department of Medicine at Saidu Group of Teaching Hospital, Swat, Pakistan. Laboratory investigations were conducted at the Department of Pathology and Laboratory Medicine of the same institution. The duration of the study spanned one year, from February 1, 2022, to January 31, 2023.

Participants

The study population included both male and female patients aged between 15 and 70 years who presented with clinical symptoms suggestive of UTIs, such as dysuria, frequency, urgency, abdominal pain, or hematuria. Exclusion criteria comprised individuals who had undergone recent urological procedures, patients with recurrent sexually transmitted infections, those who had used antibiotics in the last seven days, and patients above 70 years of age.

Variables

The primary variables assessed were demographic details (age, gender), clinical characteristics, and microbiological profiles of urine samples. The outcome variable was the identification and prevalence of bacterial species isolated from urine cultures.

Data Sources/Measurement

Mid-stream urine samples were collected in sterile culture and sensitivity containers containing boric acid to preserve the sample. All specimens were immediately transported to the laboratory and processed within two hours. Samples were inoculated on culture media and incubated at 35–37°C for 18–24 hours. Bacterial colonies were identified through

morphological characteristics, Gram staining, and standard biochemical tests. Antibiotic susceptibility testing was also performed according to established protocols.

Bias

To minimize bias, strict inclusion and exclusion criteria were followed. All samples were processed immediately under standard laboratory operating procedures to reduce contamination risk. Moreover, only first-time cases without recent antibiotic exposure were included to avoid skewed culture results.

Study Size

The sample size was initially calculated using OpenEpi (WHO calculator) with an anticipated frequency of 71%, a population size of one million, a 5% margin of error, and a design effect of 1. This yielded a minimum required sample size of 317. However, to enhance reliability and representativeness, a total of 1000 patients were ultimately included in the study.

Quantitative Variables

Age was treated as a continuous variable and expressed as mean ± standard deviation (SD). Categorical variables, such as gender distribution and bacterial species, were analyzed as frequencies and percentages.

Statistical Methods

All data were entered and analyzed using SPSS version 26. Descriptive statistics were used to summarize demographic and microbiological findings. Fisher's exact test was applied to evaluate the association between bacterial isolates and gender. A p-value of less than 0.05 was considered statistically significant.

Table # 1: Gender Distribution & Frequency of different type of Bacteria isolated from Urinary Culture

Gender Distribution			
Gender	**Male**	**Female**	
Frequency	275 (27.50%)	725 (72.50%)	
Frequency of different type of Bacteria isolated from Urinary Culture			
Bacteria Isolated	**Frequency**	**Percentage**	**Level of significance**
Escherichia Coli	704	70.40 %	
Klebsiella Species	40	4.00 %	P=0.0423
Proteus species	19	1.90 %	
Pseudomonas aeruginosa	18	1.80 %	
Enterococcus species	17	1.70 %	
Citrobacter species	17	1.60 %	
Staphylococcus species	16	1.60 %	
No Growth	169	16.90 %	

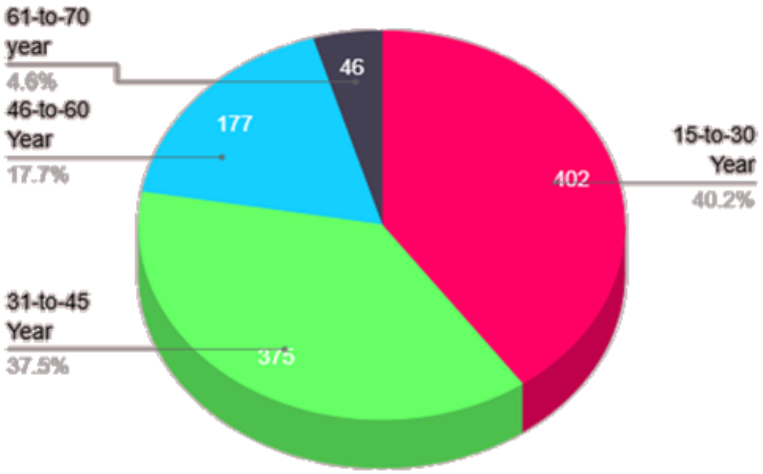


Figure 1: Age Group distribution.

Results

Participants

A total of 1000 patients presenting with symptoms of urinary tract infections were enrolled in this study. Among them, 725 (72.5%) were female and 275 (27.5%) were male, reflecting the higher prevalence of UTIs among women. The mean age of participants was 35 ± 4.5 years. All participants met the inclusion criteria, and none of the excluded categories (recent urological procedures, recurrent sexually transmitted infections, recent antibiotic use, or age >70 years) were represented in the final sample.

Descriptive Data:

The age distribution was divided into four groups. The largest proportion of patients, 402 (40.2%), fell in the 15–30 years age group, followed by 375 (37.5%) in the 31–45 years age group. Patients aged 46–60 years accounted for 117 (17.7%), while only 46 (4.6%) participants were between 61–70 years. This age distribution suggests that UTIs were most common in individuals of reproductive and middle age.

Outcome Data:

Urine culture and sensitivity tests were performed for all 1000 patients. Bacterial growth was observed in 831 (83.1%) samples, whereas 169 (16.9%) samples showed no bacterial growth. Among positive cultures, Escherichia coli was the most frequently isolated organism, identified in 704 (70.4%) cases. Other bacteria included Klebsiella species (40 cases; 4.0%), Proteus species (19 cases; 1.9%), Pseudomonas aeruginosa (18 cases; 1.8%), Enterococcus species (17 cases; 1.7%), Citrobacter species (17 cases; 1.7%), and Staphylococcus species (16 cases; 1.6%).

Main Results:

The analysis demonstrated that E. coli was by far the most prevalent uropathogen in both genders and across all age groups, confirming its central role in the etiology of UTIs. A statistically significant association was found between gender and bacterial isolates ($p = 0.0423$), indicating that certain bacterial species showed gender-related variation in prevalence. Overall, the study highlights that females, particularly in the younger and middle-aged groups, were disproportionately affected, and E. coli was the dominant pathogen responsible for infections.

Discussion

According to global estimates, approximately sixty-four thousand deaths from urinary tract infections could have been prevented in 2019 if all drug-resistant UTIs were replaced by susceptible infections, while an additional 0.26 million deaths could have been avoided if drug-resistant UTIs were replaced by non-infections [13]. In fact, the mortality burden caused by antimicrobial-resistant UTIs was comparable to the combined deaths from testicular cancer, urolithiasis, and other less common urological diseases in the same year [14]. This underscores the significance of antimicrobial resistance and its impact on global health outcomes. The etiology, pathogenic mechanisms, and resistance patterns of uropathogens continue to evolve, with noticeable regional variations, making ongoing surveillance essential. Accurate identification of pathogens and determination of their susceptibility profiles remain central to effective treatment, highlighting the importance of collaboration between clinicians and microbiologists [15].

Globally, UTIs are caused by a wide variety of pathogenic bacteria, with Escherichia coli being the most frequently

reported pathogen in community settings. Other important uropathogens include species of Klebsiella, Enterobacter, Proteus, Pseudomonas, Staphylococcus, Streptococcus, and Enterococcus faecalis [16]. The findings of our study align with this evidence, as E. coli was the most frequently isolated bacterium from urine samples, followed by Klebsiella and Proteus species. Data from India also support this observation, where E. coli has consistently been the dominant isolate, reported in approximately 72% of cases, followed by Klebsiella species at 15% [16]. Another Indian study in community settings found E. coli to be the leading pathogen (55.1%), followed by Enterococcus faecalis (15.8%) and Klebsiella pneumoniae (13.7%) [17]. Similarly, further reports demonstrated E. coli as the cause of 74.3% of UTIs, with Klebsiella pneumoniae accounting for 20.1% [18]. Numerous other studies have also documented E. coli as the primary cause of UTIs across different regions [19].

Gender-based distribution in our study revealed that the majority of patients were women (75.5%), a finding consistent with reports from other studies [19]. This is expected since women are at higher risk of UTIs due to anatomical differences, such as a shorter urethra located in close proximity to the gastrointestinal tract, which facilitates bacterial entry [20]. Nearly half of all women experience at least one UTI episode in their lifetime, with the highest frequency observed among women over the age of 25 [18]. Although UTIs are less frequent in men, existing evidence suggests that symptoms may be more severe and complicated when they occur [20].

In our study, E. coli was the predominant pathogen, responsible for 70.4% of cases. These findings are comparable with reports from Canada and Ethiopia, where E. coli accounted for 80–90% of UTIs [21,22]. In Pakistan, similar results have been documented: 63% prevalence of E. coli in Rawalpindi [23], 80% in Lahore [24], and 77% in Peshawar [25]. Collectively, these studies strongly support the central role of E. coli in UTI pathogenesis both globally and locally.

The large sample size of 1000 patients in this study enhances the representativeness of findings and strengthens the reliability of conclusions. However, a key limitation is that the study was conducted at a single center, which may restrict generalizability. Future multicenter studies incorporating antimicrobial resistance profiling are warranted to capture broader epidemiological trends and guide more effective treatment strategies.

Conclusion

This study confirmed that Escherichia coli is the predominant uropathogen, responsible for more than two-thirds of UTIs in the study population. Its high prevalence across both genders and particularly among individuals aged 15–45 years underscores its clinical significance. The strong association between gender and bacterial isolates further emphasizes the need for tailored preventive and management strategies.

The consistent dominance of E. coli highlights the importance of continuous local surveillance and antimicrobial stewardship programs. Further research into its virulence mechanisms and resistance patterns is essential to optimize treatment protocols, reduce recurrence, and ultimately lower the overall burden of UTIs.

Authors' Contributions:

All authors meet the ICMJE criteria for authorship. They have reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Author 1: Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 2: Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 3: Analysis and interpretation of data, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 4: Analysis and interpretation of data, critical revision, final approval, agreed to be accountable for all the work.
Author 5: Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 6&7: Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.

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