Original Research Article

Comparative Sensitivity of Nitrofurantoin versus Fluoroquinolones against *E. coli* Isolates from Urinary Tract Infections: A Single-Centre Study

Abstract

Background and Aim: Antibiotic resistance is often seen as a potential consequence of using antimicrobial agents. This issue has been observed in cases of long-term prophylaxis for UTI and in elderly patients with renal failure.The purpose of this study was to determine the prevalence of UTI and evaluate the antibiotic sensitivity patterns.

Material and Methods: This study presents a clinic-pathological analysis conducted for urine analysis in the department of urology and other associated departments of the**Gujarat Adani Institute of Medical Sciences, Bhuj, Gujarat**.A total of 181 urine samples were collected from patients with UTI at **GKGeneral Hospital**, from various departments, ensuring a sterile environment.The identification and **Antibiotic susceptibility testing**(ABST) were conducted following standard microbiological guidelines. The results were interpreted according to the guidelines set by CLSI M100 (Clinical and Laboratory Standards Institute).

Results: We processed a total of 181 urine samples from various departments of the medical college. The study included 120 females and 61 males, with a ratio of 2:1. Positive growth was observed in 96 samples, which accounts for 50% of the cases. **E. coli was the most frequently identified isolate, appearing in a total of 32 samples. It was followed by Klebsiella pneumoniae and Pseudomonas aeruginosa.Based on the antibiotic sensitivity testing, Nitrofurantoin demonstrated a sensitivity rate of 84.37% in E. coli isolates. However,**

Fluoroquinolones such as Ofloxacin, Levofloxacin, and Ciprofloxacin exhibited lower sensitivity rates of 37.5%, 31.25%, and 31.25% respectively.

Conclusion:E.coli is the most common pathogen that causes UTIs. After comparing two groups of antibiotics, it was found that Nitrofurantoin is the most sensitive oral antibiotic when compared to fluoroquinolones. Because of its exceptional sensitivity, it can be used as an empirical treatment for UTI at our centre.

Key Words: Antibiotic resistance, E. Coli, Fluoroquinolones, Nitrofurantoin, Urinary Tract Infection

Introduction

Urinary tract infections are a frequently encountered infectious disease, ranking closely behind upper respiratory tract infections in terms of prevalence.[1] The urinary tract is a complex system that spans from the urethra all the way up to the kidneys. Typically, bacteria travel from the urethra to the bladder, leading to a urinary tract infection. When pathogens spread to the kidneys, it can result in a renal parenchymal infection. Occasionally, UTIs can occur due to infection spread through the bloodstream. UTIs can manifest in different ways depending on the location of the infection, such as urethritis, cystitis, and pyelonephritis. On a global scale, community-acquired UTIs can have a prevalence rate of up to 0.7%. Several factors contribute to the risk of developing these UTIs, such as age, previous history of UTIs, sexual activity, and diabetes.[1,2]

The Enterobacteriaceae are commonly found to be the main cause of urinary tract infections. E. coli is a prevalent culprit behind UTIs, whether they are acquired in the community or in a hospital setting. Some bacteria have a natural resistance to antibiotics, while others can develop resistance over time. Understanding the culture and antibiotics susceptibility testing of urine is crucial for diagnosing infections and monitoring the patterns of antibiotic resistance in uropathogens.[3,4]

Antimicrobial resistance among bacterial pathogens poses an increasingly concerning threat to public health.[3] Addressing antimicrobial resistance is of utmost importance, and there is an urgent need for effective treatment strategies to combat bacterial infections while minimising the development of resistance. Urinary tract infections are a frequent occurrence in the ambulatory care setting, leading to around 8 million antibiotic prescriptions annually in the United States.[5] Dealing with urinary tract infections has become more

challenging as antibiotic-resistant Gram-negative bacteria continue to emerge. The issue of fluoroquinolone resistance among uropathogens like Escherichia coli is a significant concern.[5-7] Antibiotic resistance is often seen as a potential consequence of using antimicrobial agents.**Antibiotic resistance is a growing global public health concern which is affecting the health and financial state of the patients and the community. Despite growing awareness among medical professionals there remains some gaps somewhere which needs to be bridged.**This issue has been observed in cases of long-term prophylaxis for UTI and in elderly patients with renal failure. In long-term use, there may be some risks associated with **Nitrofurantoin** (NF), although it is generally considered a safe antimicrobial drug. **It is effective against most gram-positive and gram-negative organisms. The FDA approved nitrofurantoin in 1953 to treat lower urinary tract infections. Nitrofurantoin is a synthetic antimicrobial created from furan and an added nitro group and a side change containing hydantoin.**According to a study by Vickery et al. (2022), these risks occur in approximately 1 per 100,000 patients. The adverse effects of NF, such as hepatotoxicity, neuropathy, and pulmonary damage, are directly linked to its prolonged use, without any resistance to drugs.[8,9]The purpose of this study was to determine the prevalence of UTI and evaluate the antibiotic sensitivity patterns. Additionally, it aimed to compare the effectiveness of Nitrofurantoin and Fluoroquinolones in order to identify the most suitable drug for empirical treatment of UTI.

Material and Methods

This **study presents a clinic-pathological analysis** conducted for urine analysis in the department of urology and other associated departments of the **Gujarat Adani Institute of Medical Sciences, Bhuj, Gujarat**. The study was conducted over a span of 6 months. We

collected a total of 181 urine samples from patients who were suspected to have clinical conditions, and these samples were included in the study.

Criteria for inclusion: UTIs that are uncomplicated (without any anatomical or functional abnormalities), cystitis, burning during urination, increased frequency, urgency, pain above the pubic symphysis, asymptomatic bacteriuria in pregnant women, recurrent UTIs, and unexplained fever.

Exclusion criteria: We **did not**include pregnant women, prisoners. Additionally, we **did not** include cases where the antibiotic prescription was filled more than 3 days after the initial visit or where incomplete documentation makes it impossible to identify the prescribed antibiotic.

The study took place from September 2022 to February 2023. A total of 181 urine samples were collected from patients with UTI at **GK General Hospital**, **Bhuj** from various departments, ensuring a sterile environment. A clean catch mid-stream urine sample was collected from the patients and transported to the referral tertiary care health centres for further processing, just as a health educator would recommend.

The efficiency of laboratory equipment such as an incubator, autoclave, hot air oven, and refrigerator was regularly monitored. Every effort was made to ensure that the reagents, media, and antibiotic discs were thoroughly inspected for their expiration dates and appropriate storage conditions. The media and reagents were correctly labelled with the date of preparation. Standard control strains were used to conduct sterility and performance testing.

They were promptly transported to the microbiology lab for **Gram staining** and semi-quantitative culture. The identification and ABST were conducted following standard microbiological guidelines. The results were interpreted according to the guidelines set by CLSI M100 (Clinical and Laboratory Standards Institute).

Statistical analysis

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2019) and then exported to data editor page of SPSS version 19 (SPSS Inc., Chicago, Illinois, USA). Quantitative variables were described as means and standard deviations or median and interquartile range based on their distribution. Qualitative variables were presented as count and percentages. For all tests, confidence level and level of significance were set at 95% and 5% respectively.

Results

The study aimed to determine the prevalence of UTI and evaluate the antibiotic sensitivity pattern. Additionally, it sought to compare the effectiveness of Nitrofurantoin and Fluoroquinolones as empirical treatments for UTI.

We processed a total of 181 urine samples from various departments of the medical college. The study included 120 females and 61 males, with a ratio of 2:1. Positive growth was observed in 96 samples, which accounts for 50% of the cases. E**. coli was the most frequently identified isolate, appearing in a total of 32 samples. It was followed by Klebsiella pneumoniae and Pseudomonas aeruginosa.**

Here is the demographic analysis of the patients who tested positive for E. coli: Out of the total, 11 individuals (34.38%) were male, while 21 individuals (65.63%) were female. According to the age distribution, there were 4 (12.5%) patients who were children and teenagers, aged between 0 and 17 years. The majority, 22 (68.75%) patients, were adults between the ages of 18 and 64. Lastly, 6 (18.75%) patients were elderly individuals, aged 65 years and above.

Based on the antibiotic sensitivity testing, **Nitrofurantoin demonstrated a sensitivity rate of 84.37% in E. coli isolates. However, Fluoroquinolones such as Ofloxacin, Levofloxacin, and Ciprofloxacin exhibited lower sensitivity rates of 37.5%, 31.25%, and 31.25% respectively.**

Table 1: AssociationofUTIswithrespecttovariousattributes

Gender	Sample size	E coli positive	P – value
Male	61	11	0.03
Female	120	21	
Age groups	0 – 17	4	0.016
	18 – 64	22	
	> 65	6	

Discussion

Having an accurate and rapid diagnosis is essential for effectively managing and treating diseases. UTIs cover a variety of clinical conditions that occur when bacteria invade the tissues lining the urinary tract, from the kidneys to the urethral opening. Resistance to antibiotics in clinically relevant bacteria is a major concern for public health, especially for vulnerable patient populations.[10,11] **Nitrofurantoin was widely used to treat lower urinary tract infections until the 1970s, when trimethoprim-sulfamethoxazole and newer beta-lactam antibiotics became available. Several major guidelines have recently declared nitrofurantoin the first-line therapy for treating uncomplicated lower urinary tract infections. Increasing resistance to newer antibiotics coinciding with an increasing prevalence of extended-spectrum beta-lactamase (ESBL) producing bacteria has led to a resurgence in the prescriptions of nitrofurantoin.**

E. coli is a frequently found bacterium in the gastrointestinal tract of both humans and animals. It plays a crucial role in preserving the equilibrium and stability of the microbial flora. This is accomplished through a mutually beneficial partnership with its hosts. Typically, this bacterium poses no threat to healthy individuals as long as it stays confined in the intestinal lumen. However, specific strains of the bacterium can cause diarrhoea in certain circumstances. In addition, different strains of E. coli have acquired unique characteristics that allow them to thrive in specific environments and cause three main types of illnesses: enteric/diarrheal disease, urinary tract infections (UTIs), and sepsis/meningitis.[12,13]

From a total of 181 mid-stream urine samples, only 96 samples showed positive results for culture. In the current study, the occurrence of **Gram**-negative bacteria is noticeably lower in comparison to the findings of other researchers. In their study, they found that more than 40% of the bacteria were Gram-negative. E. coliemerged as the predominant isolate across all the samples. This finding contradicts certain prior studies.[11,13] The increased occurrence of E. coli in UTIs may be due to its strong attraction to the glycoconjugate receptor found on uroepithelial cells.[12,13]

Out of the 32 isolates of E. coli, 21 were found in female patients, with the remaining 11 being from male patients. In Nepal, researchers discovered similar findings, where a greater proportion of positive isolates were found in females (30-51.98%) compared to males (18.83-48.01%).[12] Based on the results of this study, it was noted that women were more prone to UTIs than men. This finding aligns with studies conducted by other researchers.[7,9,10] There are several factors that can contribute to a higher occurrence of UTIs in females. These include anatomical differences, hormonal changes, and disruptions in urodynamic function that can happen as women age.[7,12] While most patients suspected of having UTIs fell between the ages of 19 and 65,

it was noted that patients over the age of 65 had a higher likelihood of developing UTIs ($p < 0.05$). There is a potential connection between this and a compromised immune system, which may heighten their susceptibility to the infection.

Limitations of the study were: the study was conducted at a single medical center (GKGH). This limits the generalizability of the findings to other geographic locations or healthcare settings, where antibiotic resistance patterns may differand While *E. coli* was the most common isolate, the detailed analysis focused primarily on this pathogen. The lack of comprehensive data on other isolated organisms limits the study's overall utility in understanding UTI pathogens and their antibiotic sensitivities.

Conclusion

Our research uncovered a greater occurrence of urinary tract infections among women and adults. Based on this study, it was discovered that E.coli is the most common pathogen that causes UTIs. After comparing two groups of antibiotics, it was found that Nitrofurantoin is the most sensitive oral antibiotic when compared to fluoroquinolones. Because of its exceptional sensitivity, it can be used as an empirical treatment for UTI at our centre.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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