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Analyzing the Antibiotic Susceptibility Patterns in Patients Diagnosed with Urinary Tract Infections: An Evaluation

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Abstract

Background: Antimicrobial resistance is a public health risk for treating community-acquired urinary tract infections. Urinary Tract Infection (UTI) is a common and significant clinical issue. Recurrent UTIs can result in renal scarring, hypertension, and end-stage renal failure later in life. The goal of the study was to assess the bacterial composition and antibiotic susceptibility pattern of patients with urinary tract infections (UTIs) attending DHQ Hospital Mirpur, AJK, Pakistan.

Methods: We conducted a retrospective review of clinical records at DHQ Hospital Mirpur AJK from February to August 2023, focusing on urinary tract infections. We identify urinary tract pathogens and their immune responses to guide effective treatment strategies and address drug resistance.

Results: The study found that Escherichia coli was the most common infection, accounting for 29.7% of cases. Other prevalent pathogens were Klebsiella spp. (21.2%), Staphylococcus aureus (24%), and Enterococcus faecalis. Candida spp., Serratia marcescens, and Neisseria meningitidis were found in a minority of patients. Some antibiotics, such as chloramphenicol (89.9%), tigecycline, neomycin, vancomycin, and amikacin (100%), shown great sensitivity. Others demonstrated reduced sensitivity, such as levofloxacin (34.4%) and cefoxitin (26.3%). Overall, the findings highlight the necessity of selecting antibiotics depending on their efficacy against certain infections.

Conclusion: In conclusion, this study provides valuable insights into the prevalence, bacterial composition, and antibiotic susceptibility patterns of urinary tract infections (UTIs). Escherichia coli was identified as the most prevalent pathogen, emphasizing the need for targeted treatment strategies. The variable responses to different antibiotics highlight the importance of selecting appropriate antibiotics based on local resistance patterns to ensure effective management of UTIs and combat the emergence of antibiotic resistance.

Keywords: Susceptibility, Urinary Tract Infection (UTI), Antibiotics

Introduction

Urinary tract infections (UTIs) are caused by infectious organisms such as bacteria, fungi, viruses, and parasites that spread throughout the urinary system (bladder, kidney, urethra, ureters, and urine) [1]. It is the most prevalent cause of morbidity in the general population and hospital admission [2]. Globally, 150 million individuals are diagnosed with UTI every year, resulting in a healthcare cost of more than 6 billion US dollars for treatment and job loss [3]. UTI occurs in all age groups and genders. As a result of anatomic location, physiological changes, vaginal intercourse, use of contraceptive techniques such as spermicide and diaphragm, and lack of prostatic fluid, which functions as an antibacterial agent, over 50% of women experience at least one episode of UTI during their lifetime [4, 5]. Even while UTI episodes are less common in men than in women, they are more dangerous when they do occur.

Despite the obvious increased risk of UTI, doctors lack scientifically validated approaches for identifying and treating patients with UTI complaints. As a result, UTI can lead to major problems such as recurrent infections, bacteremia, renal failure, and premature birth [6, 7, 8, 9]. Compared to other uropathogens, bacterial urinary tract infections are the most prevalent and severe diseases in humans, occurring often in the community and hospital settings. Gram-negative bacteria such as Escherichia coli,

Klebsiella spp., Enterobacter spp., Proteus spp., Pseudomonas spp., Acinetobacter spp., Serratia spp., and Citrobacter spp. are the most common causes of UTIs, accounting for 90% of cases. Group B streptococci, Enterococcus spp., and Staphylococcus spp. are Gram-positive bacteria that account for the remaining 10% of UTI cases. E. coli are the most prevalent and commonly isolated uropathogens, accounting for 65–90% of urinary tract bacterial infections. Factors such as age, gender, catheterization, hospitalization, and antibiotic exposure might impact the prevalence of both Gram-positive and Gram-negative bacterial infections.

Although few research have examined the prevalence of UTIs in the general population, the majority of studies focus on specific target groups such as HIV patients, diabetic patients, pregnant women, children, and students. A similar scenario exists in our nation, with inadequate research on UTIs, risk factors, and treatment resistance profiles accessible among the general population. To design community-wide UTI control methods, we must first appropriately diagnose infections and understand the risk factors that contribute to illness and antibiotic resistance trends in the general population. To our knowledge, no such data are available for the current research region [10, 11, 12]. A thorough understanding of the numerous variables that contribute to UTIs in the general population, their incidence rate, and the state of medication resistance in uropathogens can assist healthcare planners and policymakers in developing suitable management and control plans in the research region. The current study intended to establish the frequency, risk factors, and antimicrobial susceptibility patterns among the general population of Mirpur AJK, Pakistan.

Materals and Methods

We have out a retrospective analysis on pediatric patients aged 12 to 76 years. From February to August 2023, samples were collected from inpatients and outpatients at DHQ Hospital Mirpur AJK Pediatrics suffering from febrile urinary tract infection (UTI). Febrile UTI is characterized by a temperature of 38°C or higher, ≥5 white blood cells on a high-power microscope, and ≥105 colony-forming units (CFU)/mL in urine culture. In all, 336 patients were included. For toilet-trained children, urine samples were collected using the midstream approach, whereas for non-toilet-trained children, a sterile bag was utilized. Bacterial identification and antibiotic resistance were carried out in accordance with Clinical and Laboratory Standards Institute recommendations. Bacterial identification and antibiotic resistance testing were done in accordance with Clinical and Laboratory Standards Institute standards. Bacterial screening was done on sheep blood and MacConkey agar plates, and those with more than 105 CFU/mL were classified as having a urinary tract infection. Antibiotic susceptibility tests are performed on isolates.

The data was analyzed using IBM SPSS Statistics version 20.0 (IBM Inc., Armonk, NY, USA). Data were stratified according to the prevalence of various uropathogens, and susceptibility patterns were reported as percentages. Statistical significance was determined at the p-value < 0.05 level.

The hospital's Ethical Committee reviewed and approved the research protocol. The committee carefully reviewed the protocol to ensure that the study would be conducted in an ethically responsible manner while protecting the participants' rights and well-being. This approval confirms that the study attempt met the committee's ethical requirements and recommendations.

Results

The cultures acquired in research comprising 321 instances of UTIs produced some intriguing results. 45.5% of these instances (e.g., 146) had no growth, which means there were no bacteria or fungi present. Positive cultures were found in the remaining 54.5% (175) of the cases, indicating the presence of different species. A total of 175 people, 54.5% had a positive urine culture suggestive of urinary tract infection. Specifically, 124 females (71%) and 51 males (29%) tested positive for UTI. The analysis of the positive cultures showed that Escherichia coli was the most prevalent, accounting for 29.7% (52) of the cases. It was followed by Klebsiella spp. with 21.2% (37) cases, Pseudomonas spp. with 4% (7) cases, Proteus spp. with 2.2% (4) cases, and Staphylococcus aureus with 24% (42) cases. Furthermore, 8% (14) cases had Enterococcus faecalis, 4.75% (8) cases had Candida spp. and Serratia marcescens, and 1.7% (3) cases had Neisseria meningitidis. These results underline the significance of a precise diagnosis and suitable therapy for patients, as well as the wide variety of bacterial and fungal species linked to UTIs. On the basis of the particular organisms found in positive cultures, more research and focused treatments could be required.

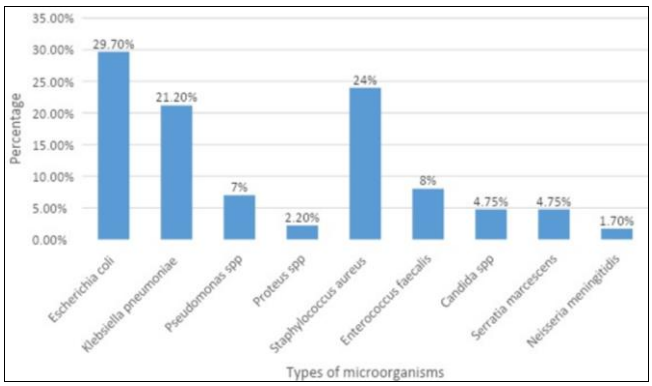

Fig 1: Types of microorganisms isolated in the study

Antibiotic susceptibility patterns in individuals with urinary tract infections were analyzed, and responses to 27 antimicrbials were shown to be variable. Some antibiotics showed high sensitivity rates, indicating that they are helpful in treating infections. Chloramphenicol showed a remarkable sensitivity of 89.9%. Furthermore, tigecycline, neomycin, vancomycin, and amikacin had a 100% sensitivity rate, making them reliable therapy alternatives. Linezolid revealed a sensitivity rate of 85.4%, whereas rifampicin showed an 82% rate. These findings show that they are highly effective in treating urinary tract infections. Among the other medicines examined, meropenem had a sensitivity rate of 87.3%, indicating a positive response in infection treatment. Impenem and tazobactam, on the other hand, had sensitivity rates of 76.4% and 71.7%, respectively, showing moderate sensitivity. Gentamicin, cephalexin, and cefepime had sensitivity rates of 74.6%, 66.7%, and 51.0%, respectively.

Levofloxacin, while less effective than some other antibiotics, nonetheless had a sensitivity rate of 34.4%. Cefoxitin had a sensitivity rate of 26.3%, indicating limited effectiveness. Tetracycline, however, had a sensitivity rate of only 20.5%, indicating lower efficacy against the detected infections. Ceftriaxone, amoxicillin, and cefuroxime had rates of 9.52%, 14.30%, and 35%, respectively, indicating lesser efficacy in treating urinary tract infections. Finally, ciprofloxacin demonstrated a sensitivity of 22.2%.

Overall, these data emphasize the varying reactions of antibiotics to urinary tract infections. It is critical for healthcare providers to examine these susceptibility patterns when choosing antibiotics for successful therapy.

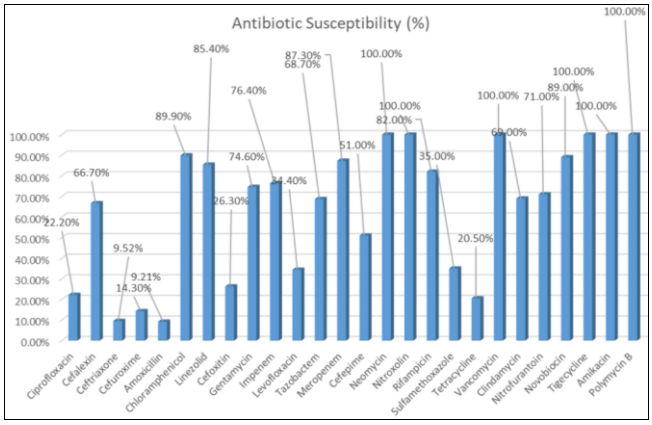

Fig 2: Antibiotic susceptibility rate

Discussion

The findings of this study, which included 321 cases of urinary tract infections (UTIs), give important information about the frequency and distribution of bacterial and fungal species associated with UTI.

The results showed that 45.5% of the cases had no growth, indicating the absence of bacteria or fungus. This might be due to a variety of circumstances, including incorrect urine sample collection or non-infectious causes of urinary symptoms. However, positive cultures were found in 54.5% of the cases (175 cases), showing the existence of distinct species. The distribution of positive cultures revealed a greater frequency of UTIs in females (71% vs. 29% in males). This is consistent with earlier research, which has revealed a greater frequency of UTIs in women due to anatomical variations and hormonal variables (Foxman, 2002) [13].

Escherichia coli was the most common pathogen detected in positive cultures, accounting for 29.7% of cases. This study supports the well-known fact that E. coli is the most prevalent cause of UTIs (Flores-Mireles *et al*., 2015) [14]. Klebsiella spp. was the second most common, accounting for 21.2% of cases, followed by Staphylococcus aureus (24%), Pseudomonas spp. (4%), Proteus spp. (2.2%), Enterococcus faecalis (8%), Candida spp. (4.75%), Serratia marcescens (4.75%), and Neisseria meningitidis (1.7%). These findings highlight the need of correct diagnosis and effective treatment for UTIs. Treatment approaches should be tailored to the individual organisms detected in positive cultures, taking into account their antibiotic susceptibility and possible resistance mechanisms. The difference in species distribution emphasizes the significance of empirical treatment guidelines that use local epidemiology data (Gupta *et al*., 2011) [15].

The results of this investigation shed light on the patterns of antibiotic susceptibility in individuals with UTIs. The observed variability in reactions emphasizes how crucial it is to choose the right antibiotics for a successful course of therapy.The effectiveness of amikacin, tigecycline, neomycin, vancomycin, and chloramphenicol in treating UTIs is demonstrated by their high sensitivity rates. These outcomes are in line with other research (Schito, 2009; Tumbarello *et al*., 2011) that shown their efficacy against bacteria frequently linked to urinary tract infections [16, 17]. Both rifampicin and linezolid showed high sensitivity rates, indicating that they could be useful therapeutic alternatives. Previous research (Zhou, Yu-Feng *et al*., 2020; Tiwari *et al*., 2017) have demonstrated encouraging outcomes when these antibiotics are used to treat strains of bacteria that are resistant to several drugs [18, 19]. Conversely, certain drugs showed reduced rates of sensitivity. Comparing levofloxacin to other antibiotics studied, it showed a lower efficacy rate of 34.4% for sensitivity. This result aligns with the growing worry about the rising resistance to levofloxacin and other fluoroquinolones in the treatment of UTIs (Zhanel *et al*., 2016) [20]. Cefoxitin had a sensitivity rate of 26.3%, indicating a low level of effectiveness in the management of UTIs. This is consistent with research demonstrating that the evolution of antibiotic resistance has led to a decline in sensitivity to cephalosporins, including cefoxitin (Bryce *et al*., 2016) [21]. Tetracycline's lower sensitivity rate of 20.5% indicated that it was less efficient against the infections that were found. This is in keeping with the established frequency of tetracycline resistance in several UTI-causing organisms (Kahlmeter *et al*., 2011) [22].

The minimal efficiency of ceftriaxone, amoxicillin, and cefuroxime (9.52%, 14.30%, and 35%, respectively) in treating UTIs caused by the investigated microorganisms is evident from their low effectiveness rates. These findings are consistent with the growing body of evidence about antibiotic resistance, which means that choosing the best course of therapy requires careful thought (Hawkey *et al*., 2018; Karlowsky *et al*., 2002) [23, 24]. Notably, sulfamethoxazole has been proven to be efficacious and has a sensitivity rate of 35%. This is consistent with its ongoing usage as a therapeutic option for UTIs, particularly in areas where resistance rates are not as high Ciprofloxacin's sensitivity rate was 22.2%, which suggests that it is less effective than the other antibiotics that were tested. This result is in line with the growing reports of fluoroquinolone resistance in UTI-causing bacterial strains, including ciprofloxacin (Kahlmeter *et al*., 2010) [22].

Overall, the varied reactions shown in patterns of antibiotic susceptibility highlight how crucial it is to choose the right medicines depending on local resistance patterns and unique patient characteristics. To guarantee proper treatment and prevent the establishment of multidrug-resistant UTIs, healthcare practitioners must constantly monitor trends in antibiotic resistance and exercise vigilance.

Evidence-based guidelines for the detection and treatment of UTIs must be put into practice in order to improve patient outcomes. Local epidemiology data and the most recent research findings should be taken into account while creating these guidelines. Healthcare professionals should also be aware of the possibility of antibiotic resistance and modify treatment regimens accordingly.

These findings can be strengthened by additional study that looks at the clinical outcomes, risk factors, and patient

demographics related to certain infections. A greater insight of worldwide trends may also be gained by research comparing the prevalence and antibiotic resistance profiles of UTI-causing organisms in various geographical locations.

The results of this study emphasize how crucial it is to manage UTIs with antibiotic judiciousness and antimicrobial stewardship. When choosing empiric antibiotic treatment, it is important to take the local epidemiology and resistance tendencies into account. This strategy can lessen the emergence of antibiotic resistance and maximize the effectiveness of therapy. The necessity for novel antimicrobial drugs and other treatment options is highlighted by the rise in resistance to routinely used antibiotics, including fluoroquinolones and cephalosporins. For the treatment of UTIs, combination therapy and new drugs like nitrofurantoin and fosfomycin have gained popularity in recent years (Drekonja *et al*., 2016; Gupta *et al*., 2011). These alternative options may offer efficacy against resistant pathogens and help combat the challenge of antibiotic resistance [15, 25].

This study also highlights the significance of continuous monitoring of drug susceptibility patterns in urinary tract infections. Frequent surveillance can reveal new patterns of resistance and direct the choice of empirical treatment. To track and stop the development of resistant strains, it is crucial to build up reliable monitoring systems and encourage cooperation throughout healthcare settings.

This study's retrospective design and use of a particular range of antibiotics are two of its drawbacks. The results of the study might not accurately represent all microorganisms that cause UTIs or the frequency of resistance in various geographical areas. Future research ought to take into account a bigger sample size, a wider variety of antibiotics, and other variables including patient demographics, risk factors, and regional differences.

Conclusion

In conclusion, this study provides comprehensive insights into the bacterial composition, prevalence, and antibiotic susceptibility patterns in patients diagnosed with urinary tract infections (UTIs). The findings demonstrate the diverse range of pathogens associated with UTIs, with Escherichia coli being the most prevalent organism. The study highlights the variable responses of different antibiotics, emphasizing the need for careful selection of appropriate antibiotics based on local resistance patterns. Tigecycline, neomycin, vancomycin, and amikacin exhibited the highest susceptibility rates, making them potential effective treatment options. These findings underscore the importance of individualized treatment approaches, antimicrobial stewardship, and continuous monitoring of antibiotic resistance to optimize UTI management and combat the emergence of drug resistance. Further research is warranted to elucidate the clinical outcomes, risk factors, and geographical variations related to UTIs, facilitating the development of targeted strategies for improved patient care.

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