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Original Research Article

Antimicrobial Susceptibility Pattern of the Most Common Pathogensic, Escherichia Coli, in aTertiary Health Care Centre in Bihar, India

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Abstract:

Background: Escherichia coli is the most common pathogens that causes urinary tract infections (UTIs), affecting people worldwide. This research aimed to examine the demographic differences in pathogens, antibiotic susceptibility patterns, and UTI cases in a tertiary care facility in Bihar, India.

Methods: Patients at NMCH Patna who were thought to have UTIs provided 856 urine samples between September 2022 and August 2023. Standard microbiological methods were used to analyse the samples and identify the isolates. The Kirby-Bauer disc diffusion method was used to test for antimicrobial susceptibility, as the Clinical and Laboratory Standards Institute (CLSI) recommended. Resistance patterns were analysed statistically to look for links to demographic variables.

Results: Escherichia coli were found in the most significant number (60.32%) of the 326 samples tested positive for bacterial growth. Klebsiella pneumoniae (12.3 %), Pseudomonas aeruginosa (8.46 %), and Proteus spp. (3.9 %) were also found to be present in the isolates. Women between 20 and 39 had the highest rate of E. coli-caused UTIs (56.6%). Testing for antimicrobial susceptibility showed that Amikacin (82.7% sensitive) and Tobramycin (71.68% sensitive) were the most effective, while Amoxycillin (71.2%), Cefixime (81.4%), and Cotrimoxazole (76.2% resistant) were the least effective.

Discussion: The prevalence of pathogens and the diversity of their susceptibilities emphasised the importance of individualised empirical therapy. The demographic differences highlighted by the age and gender distribution of E. coli-induced UTIs have potential implications for clinical treatment. Analyses of correlations hinted at differences in susceptibility with age, highlighting the need for individualised treatment plans. Compared to global literature, regional literature revealed shared and distinguishing features, highlighting the need for both.

Conclusion: This investigation investigating pathogens prevalence and antibiotic resistance in a healthcare facility in Bihar, India, is thorough. Given the rates of resistance seen against routinely used antibiotics, it is clear that clinical guidelines need to be revised regularly. We recommend future study approaches to improve our understanding and guide more effective management measures, such as genetic analysis of resistance pathways and longitudinal studies. Constant monitoring is required to adjust to the ever-changing antibiotic resistance landscape and to maximise the efficacy of ad hoc approaches to treating UTIs.

Keywords: Amikacin, Antibiotic Resistance, Antimicrobial Susceptibility, Cefixime, Ceftriaxone, Clinical Guidelines, Cotrimoxazole, Escherichia Coli, Klebsiella pneumonia, Longitudinal Studies, Pseudomonas aeruginosa, Proteus Spp., Tobramycin, Urinary Tract Infections.

Introduction

Clinical symptoms of cystitis, pyelonephritis, and silent bacteria, as well as the detection of more than 100,000 (10^5) bacterial cells in 1 ml of urine, define a urinary tract infection (UTI). [1]. although it is rather common, it is the leading cause of illness that necessitates professional medical attention. Cystitis and pyelonephritis are examples of chronic, simple illnesses that can cause severe morbidity, death, and long-term consequences and eventually limit renal function. UTIs affect people of all ages and both sexes equally. Despite this, they occur more frequently in women than in men because of factors such the close proximity of the female urethra to the anus, increased water intake, different sexual behaviors, and higher levels of hormone activity. [2] Most cases of urinary tract infections (UTIs) are

managed with an empirical treatment rather than waiting for laboratory confirmation. Escherichia coli (E. coli) is the leading cause of genitourinary tract infections (UTIs), which can range in severity from no symptoms at all to a potentially fatal infection. Results from an AST and a urine culture are used as the primary basis for the treatment strategy.

Literature Review

Urinary tract infections (UTIs) afflict millions of people every year and are a major public health issue in every region of the world. This section reviews recent studies on antibiotic resistance, pathogens prevalence, and geographic differences in susceptibility in India; all of which are important for a comprehensive knowledge of UTIs. The global and national effects of urinary tract infections (UTIs) are investigated, as are the prevalence of Escherichia coli as a pathogen. Finally, we cover the most recent advances in treating urinary tract infections and innovative measures for antibiotic stewardship.

Trends in Antimicrobial Resistance

Recent research indicates that antibiotic resistance among pathogens is increasing, making it increasingly challenging to treat UTIs. Possible explanations for this increase include self-medication and the incorrect or excessive use of antibiotics, particularly broad-spectrum antibiotics. The most prevalent pathogens, Escherichia coli, has shown variable resistance to routinely used antibiotics, requiring a nuanced approach to therapy [3].

Clinicians have a significant dilemma with the rise of multidrug-resistant bacteria such as extended-spectrum beta-lactamase (ESBL) and carbapenemase-producing E. coli. The value of frequent surveillance and periodic changes to treatment guidelines can't be overstated, nor can the necessity of understanding regional variations in resistance patterns for adjusting empirical treatment techniques [4].

Prevalence of Pathogens in Different Regions of India

With its different demographic and geographic characteristics, India sees variances in the incidence of pathogens. Recent research reveals that sanitation, hygiene practices, and availability to healthcare facilities may all affect how widely spread pathogens are in urban versus rural locations [5]. The prevalence of Escherichia coli as the leading pathogens highlights the importance of these bacteria in the Indian setting.

Targeted interventions and monitoring programmes, considering the socio-economic and environmental factors contributing to the variability in pathogenic profiles, are needed because of the wide variation in prevalence rates among regions. The development of region-specific treatment guidelines and the implementation of efficient public health interventions necessitate the investigation of these differences.

Global and National Burden of UTIs

UTIs are a significant problem around the world, with millions of cases recorded each year. UTIs are extremely common in India, affecting people of all ages and economic backgrounds. Anatomical differences, hormonal changes, and social norms are more prevalent among females [6].

Among the many bacteria that cause urinary tract infections, Escherichia coli stand out as a primary culprit. Its widespread occurrence is symptomatic of systemic problems, such as improper use of antibiotics and a lack of suitable sanitation facilities. Accurate prevention tactics and the promotion of focused healthcare interventions can be fostered by appreciating the socio-demographic factors contributing to UTIs.

Significance of Escherichia coli as a Pathogens

Multiple mechanisms contribute to Escherichia coli's success as a pathogen, including the bacterium's capacity to colonise the urinary tract, hide from the body's immune system, and build biofilms on uroepithelial cells. The genetic and molecular pathways that contribute to its pathogenicity have been unravelled in recent studies, providing insights into possible treatment targets. Beyond its widespread occurrence, Escherichia coli is essential because of its central role in developing antibiotic resistance. The public health burden of E. coli must be reduced. Thus, understanding how infections spread is crucial. Further inquiry is warranted because of the complexity added to our understanding of UTIs by the link between E. coli genotypes and clinical outcomes.

Recent Advancements in UTI Management and Antimicrobial Stewardship Programs

Improvements in UTI treatment aim to maximise the beneficial effects of antibiotics while minimising any adverse side effects and safeguarding against the emergence of resistance. Antimicrobial susceptibility testing to inform individualised treatment plans has grown in popularity. Pathogensic (UTI) management accuracy has increased thanks to the development of molecular diagnostic technologies for quickly identifying pathogens and their resistance profiles [7]. Responsible antibiotic usage can be encouraged via antimicrobial stewardship programmes. Education, surveillance, and adherence to evidence-based norms have all received more attention thanks to recent initiatives. Antibiotic resistance is a growing

problem, and clinicians, microbiologists, and chemists are working together to find a solution.

Urinary tract infections (UTIs) are changing over time, as evidenced by factors such as rising antibiotic resistance, pathogens incidence between regions, and Escherichia coli's central role. Antimicrobial stewardship programmes and the incorporation of recent advances in UTI management are crucial in resolving this public health issue. More in-depth study and an expanded comprehension of the complexities of UTIs are needed to develop more efficient preventative measures and therapeutic approaches.

Materials and Methods

The current study was conducted at NMCH Patna Bihar at the Microbiology department. The Institute Ethical Committee gave its authorization to conduct this study from September 2022 to August 2023. With the patient's permission, a urine sample was taken to test for a urinary tract infection. Urine samples were collected using the correct technique. Urine samples were initially collected after the patient was given instructions. Urine samples were obtained midstream using a clean catch and analyzed right away.

Standard loop and semi-quantitative methods were used to culture the urine samples. The model was thoroughly combined before being injected with 0.001 ml of urine onto Cystine Lactate Electrolyte Deficient (CLED) medium. Overnight at 37 degrees Celsius, the inoculated CLED medium was exposed to aerobic conditions.

Colony-forming units (CFU) per milliliter (ml) were used to quantify the total number of bacterial cells. Let's pretend that 105 CFU/ml was the magic number. Isolate was identified using the usual conventional methods. The E. coli ATCC 25922 strain was utilized for testing the product's quality. Antibiotic sensitivity was evaluated using the Kirby-Bauer disc diffusion method. Interpretation of sensitivity and resistance was achieved by measuring the diameter (in millimeters) of the 'ZONE OF INHIBITION' around bacterial growth on a solid medium, as recommended by the CLSI (Clinical and Laboratory Standard Institute). According to CLSI recommendations, the antibiotics used to evaluate the isolates' susceptibility were amikacin, amoxycillin, cefixime, ceftriaxone, ciprofloxacin, cotrimoxazole, levofloxacin, ofloxacin, and tobramycin.

Results and Discussion

The total number of samples tested was 856, and 326 (38.08%) samples exhibited bacterial growth. Out of 326 bacterial isolates, 226 isolates were E. Coli. So, E.coli was the most common isolate, followed by Klebsiella pneumoniae (12.3%), Pseudomonas aeruginosa (8.46%), Proteus spp. (3.9%), Acinatobacter baumanii (2.1%), Staphylococcus aureus (2.3%), and Candida spp. (1.62%). The UTI cases caused by E. coli were higher in females (56.6%, 128/226) than in males (43.4%, 98/226). In this study, the UTI cases varied between 6-74 years old. The highest proportion of patients showing E. coli (100; 44.2%) fell in the age group of 20-39 years. Among this age group, the females (72%; 72/100) were more commonly affected than males (28.0%; 28/100).

The E. coli isolates were less common in patients younger than 19 and older than 60. The incidence of E. coli isolates among UTI cases was found to be most prevalent in females of age group 20-39 years (56.25%; 72/128) and males of 40-59 years (42.86%; 42/98).

Table 1: Distribution of UTI patients according to age groups and sexes

Age Groups(in years)	Males (%)	Females (%)	Total	(%) Total	Z	P
≤19	14	20	34	15.1	1	0.304
20-39	28	72	100	44.2	4.4	0.0001
40-59	42	26	68	30.1	1.9	0.0537
≥60	14	10	24	10.6	0.8	0.410
Total	98	128	226	100	2	0.0472
χ^2=10.6; df =3 p =0.014						

The antimicrobial susceptibility test against many antibiotics was performed. Among isolates of E. coli, most of the isolates were. Sensitive to Amikacin 187 (82.7%), followed by Tobramycin 162 (71.68%), Cotrimoxazole 52 (23%), Ceftriaxone 42 (18.58%). Out of the total E.coli isolates, 191 (84.5%) were resistant to at least one of the antibiotics tested.

Table 2: Antibiotic sensitivity pattern of E.coli

Antibiotics	Disc content(µg)	Sensitive	Intermediate	Resistant
Amikacin	30	187	8	31
Amoxycillin	30	20	13	193
Cefixime	5	23	18	185
Ceftriaxone	30	42	27	157
Ciprofloxacin	5	80	38	108
Cotrimoxazole	1.25/23.75	52	9	165

Levofloxacin	5	18	26	182
Ofloxacin	5	77	33	116
Tobramycin	10	162	19	45

E. coli was the most common pathogens in this study, isolated in 69.32% (226/326)UTI cases as similarly found in other studies (Kamat et al., Singhal et al. Bhattacharyya et al).[8,9] Klebsiella pneumoniae was the second most common pathogenic found in this study, followed by Pseudomonas aeruginosa and Proteus spp., which is concordant with the results observed in a study by Manikandan et al.[10]

The variable conditions like environmental factors, host factors, personal hygiene and sanitation and socio-economic status may affect the etio-pathological variations in UTI cases in different parts of the world. In the current study, the prevalence of E. coli, which was the most common pathogen isolated from urine samples across gender and age, was analysed. Among males presenting symptoms of UTI,–the males of age group 40-59 years were more frequently affected. Increased incidence of urinary obstruction due to prostatitis and bladder stones in this age group could be the reason for the above observation. The extremes of ages among males and females were found to be less commonly affected by UTI caused by E. coli in this study.

In this study, most E. coli isolates were susceptible to Aminoglycosides (Amikacin, Tobramycin), followed by Fluoroquinolone (Levofloxacin). Amikacin was most effective in E. coli isolates in this study, further supported by other studies. [11]

In this study, the E. coli isolates have shown considerable resistance against Amoxycillin, followed by oral third-generation cephalosporin Cefixime and Cotrimoxazole. So, the isolates of E. coli in this study were found resistant to the beta-lactam group of antimicrobials, probably belonging to the Extended-spectrum beta-lactamase (ESBL) group.

The Infectious Diseases Society of America (IDSA) guidelines recommended that empirical treatment of UTI cases should be based on regional and local antibiotic susceptibility patterns, available antibiotics and intolerance or allergy patterns of the successfully treated UTI cases.[12]

In developing countries like India, antibiotics like Fluoroquinolones (Ciprofloxacin, Ofloxacin) and Cotrimoxazole are the most frequently prescribed antibiotics for treating UTI cases. This study has shown that the isolates were resistant to these commonly prescribed antibiotics. As per the current study, we recommend antibiotics like Amikacin and Levofloxacin for empirical treatment of UTI cases at our centre before culture and sensitivity reports.

Discussion of Results

Consistent with previous research from various locales, Escherichia coli was the most common pathogens. More information must be provided about the prevalence of Klebsiella pneumoniae, Pseudomonas aeruginosa, and Proteus spp., all cited as pathogens. Our findings corroborate those of Manikandan et al. [10], who found that Klebsiella pneumoniae is the second most prevalent pathogens. Proteus spp. and Pseudomonas aeruginosa were also common, albeit at lower frequency.

These pathogens showed very different susceptibility profiles to several antibiotics. The susceptibility patterns must be understood to guide empirical treatment choices. For instance, Klebsiella pneumoniae might show varied degrees of resistance to the most frequently used medicines. Therefore, patients need individualised care. The fact that Pseudomonas aeruginosa is naturally resistant to multiple drugs highlights the importance of developing specific treatments for this bacterium.

Age and Gender Distribution of UTI Cases Caused by E. coli

Our analysis of the demographics of women and men with urinary tract infections due to Escherichia coli revealed some exciting disparities. E. coli-caused UTIs were more common among women than men of the same age, particularly among women aged 20–39. Higher UTI incidence in females has been linked to anatomical characteristics, hormonal impacts, and behavioural practises, consistent with the existing literature. E. coli-caused UTIs were more common in men between the ages of 40 and 59. Bladder stones and prostatitis may be to blame for the higher rate of urinary blockage seen in people of this age. In both sexes, the incidence of E. coli UTIs was lowest in the oldest and youngest age groups, indicating the presence of either a protective factor or a different underlying aetiology.

Comparison with Similar Studies

They are considering our research from the perspective of other studies conducted in India and worldwide, which is essential. Consistently, E. coli has been found to be the leading pathogens responsible for UTIs, consistent with this investigation's findings. Regional disparities in healthcare practice, socio-economic circumstances, and local epidemiological conditions may lead to variances in susceptibility patterns and demographic distributions.

The transferability of our results can be better understood by comparing them to those of other nations, particularly those with comparable healthcare systems or demographic profiles. A better worldwide understanding of UTI epidemiology can be gained from identifying and investigating differences and similarities.

Future Research Directions

The genetic basis of antibiotic resistance in pathogens, particularly Escherichia coli, should be investigated in future studies. Tracing the mechanisms underlying these trends back to the precise genetic variables that confer resistance is essential. Forecasting and managing the spread of resistance can be significantly improved by using the results of whole-genome sequencing studies to discover genetic markers.

Longitudinal investigations are crucial to monitor the development of antimicrobial resistance over time. This method helps spot patterns in the emergence of resistance and understands its dynamics. Researchers can learn about changes in resistance profiles and help healthcare professionals adjust treatment tactics by performing repeated susceptibility evaluations. This long-term view is essential for preventing the erosion of efficacy in empirical therapy and slowing the spread of antibiotic resistance.

Establishing and strengthening surveillance programmes for antibiotic resistance is crucial for directing local and national healthcare strategies. Medical professionals can make informed judgements regarding empirical treatment options thanks to real-time monitoring of resistance developments made possible by robust surveillance. This data is essential to effectively design interventions, conduct targeted antimicrobial stewardship programmes, and reduce the spread of resistant strains. New approaches should be investigated in the future to increase surveillance programmes' efficacy and scope.

Clinical Guidelines and Recommendations

The general principles mentioned in the current clinical guidelines for UTI treatment are consistent with our findings. Since Escherichia coli is so common as a pathogen, and because it is susceptible to antibiotics like Amikacin and Tobramycin, these drugs are frequently used on an empirical basis to treat urethritis. However, the discovered resistance patterns highlight the necessity of a nuanced approach, especially against Amoxycillin, Cefixime, and Cotrimoxazole. Future clinical guidelines should consider these unique resistance profiles when making empirical therapy recommendations.

The ever-changing prevalence of antibiotic resistance makes regular updates to clinical guidelines essential. Our research shows widespread opposition to routinely used antibiotics, demonstrating the critical need to modify current treatment guidelines. Periodic revisions, based on regional susceptibility patterns, ensure that recommendations continue to reflect the ever-changing resistance situation. Improved patient outcomes and reduced treatment failure rates can result from this preventative strategy, which ensures clinicians can access the most up-to-date data for making educated decisions about empirical treatment.

Conclusion

In conclusion, the results of our enlarged investigation shed new light on the geographic dispersion of pathogens, the antimicrobial susceptibility patterns, and the socio-economic differences in UTI patients.

The following research directions, including studying the genetic basis of antibiotic resistance and performing longitudinal studies, aim to expand our understanding of resistance patterns and inform targeted therapies. Continuous monitoring of susceptibility patterns is emphasised, as is the necessity of surveillance programmes informing healthcare policy. Understanding the need to adjust clinical guidelines to fit local resistance profiles is crucial as we move forward in the maze of antimicrobial resistance. Procedures should be reviewed and revised regularly to ensure that healthcare providers always have the most up-to-date knowledge to meet the problems of constantly shifting resistance patterns. Urinary tract infection (UTI) treatment techniques and the efficacy of current medications require ongoing care and research.

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