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Original Research Article

Antibiogram Analysis of Urinary Pathogens: A Retrospective Study from a Tertiary Care Centre in Dhanbad

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Abstract

Background: Urinary tract infections (UTIs) are widespread bacterial infections and constitute a healthcare-system burden in the world. It has increased the morbidity as the management of UTIs has become more difficult due to the increasing prevalence of antimicrobial resistance (AMR) in uropathogens, resulting in treatment failures. Local antibiogram data is critical in informing effective empirical therapy and resistance trends monitoring.

Methods: Microbiological records between January 2024 and December 2024 were used to conduct a retrospective observational study. The analysis was carried out on 75 culture-positive urine samples. Information on patient demographics, bacterial isolates and patterns of antibiotic susceptibility was recorded. Standard laboratory tests, such as the Kirby-Bauer disk diffusion method, were used to identify organisms and perform antibiotic susceptibility testing and interpreted based on standard guidelines.

Results: The most frequent isolate (53.3%) was Escherichia coli, and then Klebsiella (20%), Pseudomonas (13.3%), and Staphylococcus (13.3%). Imipenem exhibited maximum sensitivity (70-90%), and Nitrofurantoin was also sensitive (75-80%). The highest level of resistance was demonstrated by ampicillin (only 10-30% sensitivity). Ciprofloxacin and Ceftriaxone had moderate sensitivity. 20–25% of isolates had multidrug resistance.

Conclusion: This study has shown that constant monitoring of antimicrobial resistance is necessary and the use of local antibiogram data is essential to inform empirical antibiotic therapy. To counter the increasing resistance, rational antibiotic use and the use of stewardship programs are essential.

Keywords: Antibiogram, Antibiotic Sensitivity, Antimicrobial Resistance, Urinary Tract Infection, Uropathogens.

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Introduction

UTIs are a frequent type of bacterial infection that is faced in clinical practice, with millions of people being infected each year [1]. They are major contributors to morbidity, spending in health care as well as consumption of antibiotics, both in the community and in hospitals. UTIs may impact persons of any age, but are more common in women, elderly patients and those with underlying comorbidities, including diabetes or immunosuppression [2].

UTIs represent a significant public health issue in the world, as they constitute a significant percentage of outpatient visits and hospital admissions. The weight is especially high in developing countries because of a weak healthcare system, poor sanitation, and mass usage of antibiotics. UTIs constitute a high percentage of infectious disease cases in India and their incidence is on the rise in urban and rural populations [3]. The unification of treatment modalities and easy accessibility of antibiotics on the over-the-counter shelves further aggravate the management of the disease.

UTIs are caused by bacteria, as the range of causative agents is rather stable [4]. Among them, Escherichia coli is the most commonly isolated uropathogen, causing most of the community-acquired infections. Other pathogens that are commonly seen are Klebsiella species, Pseudomonas aeruginosa, Proteus species, Gram-positive organisms such as Staphylococcus aureus and Enterococcus species [5]. Challenges of the

distribution of these pathogens can be influenced by patient demographics, hospital environment, and geographic location. Local microbial profile is thus necessary to inform appropriate empirical therapeutic decisions and enhance a better clinical outcome [6].

The problem of UTI management has become more complicated with the emergence and spread of AMR in the short term, given the advances in diagnostic methods and antimicrobial therapy [7]. Abuse and overuse of antibiotics, self-medication and non-completion of the treatment courses have played a major role in the emergence of the resistant strains [8,9]. Consequently, this caused most common antibiotics to lose their potency, causing an extension of the duration of illness, high chances of complications, and increased health care expenses. The increasing level of multidrug-resistant (MDR) uropathogen strains is a severe threat to the effective treatment and constant monitoring of the trends in antibiotic susceptibility [10,11]. The antibiograms, which are systematic syntheses of antimicrobial susceptibility information, are important in steering clinicians in choosing antibiotics based on evidence.

Nevertheless, there is no uniformity in antibiotic resistance patterns, and they usually differ considerably among regions, healthcare facilities, and patient groups. This inconsistency highlights the need to produce local data on antibiograms in order to promote rational prescribing of antibiotics.

In areas like Dhanbad, where fewer published information has been done on antimicrobial susceptibility trends, clinicians tend to depend on ad hoc practices that might not be accurate in the existing resistance trends. This may result in the abuse of antibiotics and amplify the problem of resistance. Thus, a severe necessity to carry out region-specific research, which should examine the currently existing uropathogens and their sensitivity to different antibiotics.

The present study is undertaken with the objective of addressing this gap by providing a detailed antibiogram analysis of urinary pathogens isolated from patients in a tertiary care centre in Dhanbad. This study is expected to assist clinicians in choosing more viable empirical treatments, encourage the reasonable use of antibiotics, and constitute a portion of the current endeavors to overcome antimicrobial resistance at regional as well as national scales.

Objectives

1. To identify and determine the prevalence of urinary pathogens in culture-positive urine samples.
2. To analyze the antibiotic susceptibility patterns of the isolated uropathogens.

Materials and Methods

Study Design: The study was a retrospective observational study that could evaluate the trend of antibiotic susceptibility of urinary pathogens. The retrospective design also enabled an evaluation of the already registered microbiological data without the direct intervention of patients, making it an effective and cost-effective design for assessing local trends of antimicrobial resistance.

Study Setting: The experiment was conducted at the Department of Microbiology of one of the tertiary care centres in Dhanbad, India. The representation of the cases of UTIs in the region is full, as this healthcare facility serves a wide range of patients, both in the inpatient and outpatient units.

Study Duration: The study included data collected over a one-year period, from January 2024 to December 2024. This time was chosen to make sure that there is sufficient representation of the sample and that there are seasonal changes in the occurrence of infection and antimicrobial resistance.

Sample Size: The study involved 75 culture-positive urine samples. The samples were chosen according to positive microbiological evidence of UTI, and only the cases of clinical interest were used in the analysis of antibiogram patterns.

Inclusion Criteria: The patients enrolled in the study were of all ages and genders and had UTIs that had been confirmed through positive reports of urine culture. Only the cases where there is a substantial growth of bacteria, according to the conventional microbiological standards, were taken to qualify to be included.

Exclusion Criteria: Samples that were determined to be contaminated and that exhibited a mixed or insignificant growth were not included in the study. Moreover, the records that had incomplete patient data or laboratory data were also eliminated in order to ensure the accuracy and reliability of the analysis.

Data Collection: Hospital microbiology laboratory records and patient files were used as sources of data. Systematic extraction was carried out to bring relevant information like patient demographics (age and gender), culture results, identified organisms and patterns of antibiotic susceptibility. All patient confidentiality was maintained by anonymizing all data.

Laboratory Methods: The standard microbiological procedures were performed on urine samples. The samples were cultivated in the right media, including MacConkey agar and blood agar and incubated under the proper conditions. The isolates of bacteria were identified using

colony morphology, Gram staining, and routine biochemical tests. A Kirby-Bauer disk diffusion test on Mueller-Hinton agar was done to determine the antibiotic susceptibility.

The interpretation of the results followed the recommendations of the Clinical and Laboratory Standards Institute so that standardization and reliability of the report about the sensitivity and resistance patterns were achieved.

Antibiotics Tested: The Uropathogens identified were subjected to a panel of the most frequently used antibiotics to determine their antimicrobial susceptibility. These were Ampicillin, Ciprofloxacin, Nitrofurantoin, Ceftriaxone and Imipenem. These antibiotics were chosen because they are commonly used in clinical practice when treating UTIs.

Statistical Analysis: Data collected were entered and processed with the help of statistical analysis in SPSS. To summarize the data, descriptive statistical tools were used, with frequencies and percentages computed. The patterns of distribution of uropathogens and their pattern of antibiotic susceptibility were given in tabular and graphical form to be easily interpreted.

Ethical Consideration: The Institutional Ethics Committee of the respective tertiary care centre gave ethical approval to the study. Since this was a retrospective study, there was no need for direct involvement of the patients. Strict confidentiality was ensured in all patient data and personal identifiers were eliminated to maintain privacy and ethical standards.

Results

Demographic Distribution: A total of 75 culture-positive urine samples were analyzed in the present study. The demographic distribution of patients revealed that UTIs were more prevalent among females compared to males. Out of the total cases, 48 (64%) were females and 27 (36%) were males, indicating a higher susceptibility among women, which is consistent with known anatomical and physiological factors. Also, the majority of the cases were witnessed in the adult age group. The 21–40 years age group represented the majority of cases, 30 (40%), followed by the 41–60 years age group, 20 (26.7%). 15 (20%) cases were from the elderly population (>60 years), and 10 (13.3%) from the pediatric and adolescent group (<20 years). This distribution points out that UTIs are prevalent among sexually active and middle-aged individuals.

Table 1: Demographic Distribution of Patients

Category	Subgroup	Number (n)	Percentage (%)
Gender	Male	27	36%
	Female	48	64%
Age Group	<20 years	10	13.3%
	21–40 years	30	40%
	41–60 years	20	26.7%
	>60 years	15	20%

Distribution of Uropathogens: Urine cultures were analyzed, and it was found that the most dominant pathogen was Escherichia coli, which comprised 40 (53.3%) of the total isolates. This was succeeded by Klebsiella species, which comprised 15 (20%) cases. 10 (13.3%) samples contained Pseudomonas aeruginosa and 10 (13.3%) contained Staphylococcus species. Gram-negative organisms are dominant in the study population, indicating their prevalence in the development of UTIs.

Table 2: Distribution of Uropathogens

Organism	Number (n)	Percentage (%)
E. coli	40	53.3%
Klebsiella spp.	15	20%
Pseudomonas spp.	10	13.3%
Staphylococcus spp.	10	13.3%

Antibiotic Sensitivity Pattern: The sensitivity profile of the isolated uropathogens to the frequently used antibiotics showed that they were variably sensitive. The organisms were very sensitive to Imipenem (90%) and Nitrofurantoin (80%) and moderately sensitive to Ceftriaxone (65%) and Ciprofloxacin (55%). Nonetheless, the sensitivity to Ampicillin was rather low, at 30%.

Klebsiella species showed maximum sensitivity to Imipenem (85%), then to Ceftriaxone (60%), and Nitrofurantoin (55%). Ampicillin and Ciprofloxacin sensitivity was not high, 25% and

50%, respectively. The greatest sensitivity to Imipenem (80%), and resistance to Ampicillin (90% resistant) was found in isolates of Pseudomonas and lower sensitivity to Ciprofloxacin (45%).

Staphylococcus species was sensitive to Nitrofurantoin (75%) and Imipenem (70%) and very sensitive to Ampicillin (65%).

Table 3: Antibiotic Sensitivity Pattern of Uropathogens (%)

Antibiotic	E. coli	Klebsiella	Pseudomonas	Staphylococcus
Ampicillin	30%	25%	10%	35%
Ciprofloxacin	55%	50%	45%	60%
Nitrofurantoin	80%	55%	40%	75%
Ceftriaxone	65%	60%	50%	55%
Imipenem	90%	85%	80%	70%

Antibiotic Resistance Pattern: The resistance pattern of the current study shows that there is a worrying pattern of diminished effectiveness of the frequently used antibiotics. Ampicillin was the most resistant to all the pathogens, especially Pseudomonas (90%) and Klebsiella (75%) isolates. Ciprofloxacin also exhibited moderate levels of resistance, particularly against Gram-negative organisms.

A subset of isolates had been found to have MDR, defined as resistance to three or more antibiotic classes. About 20% and 25% of E. coli and Klebsiella isolates had MDR patterns and the implication of this is the increasing difficulty of treating UTIs using standard empirical treatment.

Discussion

The current paper offers useful information on the distribution of uropathogens and the pattern of antibiotic susceptibility to uropathogens in a tertiary care centre within Dhanbad. The results show that Escherichia coli is the most common causative agent of UTIs and then Klebsiella, Pseudomonas and Staphylococcus species. This trend is in line with the established dominance of Gram-negative bacilli in UTIs. The increased incidence of UTIs among females and the 21-40 years age group is the epidemiological trend and is probably predetermined by anatomical vulnerability and lifestyle.

The analysis of the antibiogram submitted indicated that Imipenem and Nitrofurantoin had the highest sensitivity in most of the isolates, and Ampicillin had a very high resistance rate. The low sensitivity to the widely applied antibiotics like Ciprofloxacin and Ceftriaxone indicates a threatening picture of new resistance. The emergence of multidrug-resistant strains among E. coli and Klebsiella further heightens the increasing difficulty in the management of UTIs. The results of these studies emphasize that it is necessary to monitor resistance trends regularly to select the right antibiotics.

Comparison with Other Studies: The findings of this research are consistent with the findings of other studies performed in India, whereby E. coli has always been reported as the most prevalent uropathogen [12]. Other related studies have also revealed that there is an escalating resistance to first-line antibiotics like Ampicillin and Fluoroquinolones and a more sensitive level towards Nitrofurantoin and Carbapenems [13].

Resistance trends have been similar in other parts of India as perceived in studies, which supports the alarm on the deteriorating effectiveness of popularly used antibiotics.

The distribution pattern of uropathogens and antimicrobial resistance all over the globe reflects the results of this study. The general prevalence of E. coli as the most frequent cause of UTIs and increasing resistance to broad-spectrum antibiotics has been reported in international research [14]. Multi-drug-resistant organisms have been identified as a significant health problem in the global healthcare sector [15]. Nevertheless, the intensity of resistance differs between regions and it again justifies regional antibiogram studies like in the current research.

Strengths: The advantage of this study is the fact that it uses real-world data collected in one of the tertiary care hospitals and makes it clinically relevant. The research gives region-specific data on uropathogens and resistance profile, which is especially important in the localities where it is lacking. Besides, the presence of patients of various age groups and both sexes enables one to have a larger picture of the patterns of infections.

Limitations

Despite its contributions, the study has certain limitations. A sample size of 75 is moderately small and may not sufficiently represent the broader population. The study is single-centered and thus might not apply to other regions. Moreover, retrospective design is based on the available records, which can be prone to incomplete data or documentation bias. It is advisable to conduct future research with bigger

samples and multicentric to confirm and build on these results.

Conclusion

The study demonstrates that UTIs are a serious health issue, as Escherichia coli is the most common pathogen. The sensitivity to Imipenem and Nitrofurantoin is also high, which means that the treatment is also useful and the Ampicillin response is highly resistant, which limits its application in the clinical setting. Increased problem of antimicrobial resistance is emphasized by the emergence of resistant strains that are multidrug resistant. Results support the necessity to use the local antibiogram outcomes to guide the appropriate treatment. Observation, wise antibiotic prescriptions and implementation of antibiotic stewardship programs ought to be undertaken on a routine basis in order to improve treatment outcomes as well as manage resistance. Altogether, data on the territorial level are important to the optimization of UTI management and maintenance of antibiotic effectiveness.

Recommendations

The research suggests that antibiotic stewardship programs should be reinforced in order to encourage rational antibiotic prescription and minimize resistance. To make effective treatment decisions, it is necessary to monitor changes in antimicrobial susceptibility continuously. Hospital antibiograms should also be updated periodically to assist clinicians. Prescribing patterns can be improved by raising physician awareness regarding resistance patterns. Furthermore, it is important to educate people about the correct use of antibiotics and impose stringent measures on the sale of antibiotics over-the-counter in order to fight against antimicrobial resistance.

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