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(Research Article)

A prospective study of antibiotic susceptibility pattern of uropathogens in a tertiary care hospital

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Abstract

Background: Urinary tract infection (UTI) is a frequent condition encountered in primary care. Treatment is usually empirical without urine culture and susceptibility testing because the causative uropathogens and their antimicrobial susceptibility profiles are considered to be predictable. However, there is increasing evidence of antimicrobial resistance in community- acquired uropathogens. This study aimed to assess the prevalence and antimicrobial susceptibility pattern of uropathogens causing UTI.

Methods: A prospective study was conducted over a period of six months in a tertiary care hospital in Kerala, India. A total of 100 patient case records satisfying the inclusion criteria were analysed to determine the prevalence of uropathogens causing UTI and also to determine antibiotic sensitivity pattern of uropathogens to various antibiotics. All the relevant and necessary data of the patient were collected from patient's case record and microbiology department to study the rational prescribing of antibiotics before and after culture sensitivity test. Data analysis was conducted using Chi-squared test and descriptive statistics.

Result: In this study, we observed a higher incidence of UTIs in females, particularly among individuals aged over 70 years. The primary microorganisms isolated from these cases were *Escherichia coli, Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*. Upon conducting culture sensitivity tests, approximately half of the initially prescribed antibiotics were altered. Penicillin class of antibiotic was frequently substituted, predominantly with drugs from the carbapenem class. Our analysis of antibiotic sensitivity revealed that Imipenem exhibited the highest sensitivity, followed by meropenem and colistin within our study cohort.

Furthermore, a chi-square test was conducted, yielding a chi-square value of 12.25 with a p-value less than 0.001, implies that there is a significant difference between drugs given before and after C/S was done. These findings underscore the importance of tailored antibiotic selection based on microbial sensitivity profiles, especially in elderly female patients, to ensure effective treatment outcomes for UTIs.

Conclusions: According to the research, UTIs are the most common public health issue, primarily affecting women. *Escherichia coli, Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*were the most common isolated organisms in our study that caused UTIs in IndiaMost isolates exhibited resistance to widely used antibiotics.Thus, regular surveillance and monitoring are essential for improved patient care.

Keywords: Antibiotic susceptibility; *E. coli*, Multidrug resistance; Urinary tract infection; Uropathogens

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1. Introduction

A urinary tract infection (UTI) is defined as a medical disorder in which the presence of pathogenic bacteria in the urine, bladder, urethra, kidney, and prostate is linked to clinical signs and symptoms [1]. The second most prevalent bacterial illness that affects people of all ages globally is a urinary tract infection (UTI) [2] . UTIs are thought to affect 50% of women worldwide at least once in their lifetime, and they are more prevalent in those between the ages of 16 and 64 [3]. Although UTIs are extremely rare in males, they can occur during the first year of life, especially in those with functional or structural abnormalities [4]. Additionally, UTI recurrence rates are greater, primarily due to treatment gaps or discontinuations. As a result, reinfection with the same or distinct microbes may happen [5].

There are two types of UTIs: uncomplicated and complicated. While complicated UTIs affect people of all ages and sexes, uncomplicated UTIs are more common in healthy adult non-pregnant women [2]. Renal calculi, renal failure, indwelling catheters, renal transplantation, immunosuppression, blockage, and pregnancy are risk factors for complicated UTIs [6]. Although bacteria are responsible for over 95% of UTIs, other microbes such viruses, fungi, and parasites can also cause UTIs.[7].

Gram-negative bacteria including *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Citrobacter* species, *Enterobacter* species, and *Proteus* species are the most common bacterial pathogens that cause urinary tract infections. The most frequent causes of UTIs among Gram-positive bacteria are *Staphylococcus aureus*, *Staphylococcus saprophyticus*, and *Enterococcus* species [8]. Of all the bacteria, *E. coli* is responsible for 75% to 95% of UTI cases [9].

Broad-spectrum antibiotics are frequently used for empirical treatment since they have proven to be highly effective in the management of UTIs. The improper use of antibiotics and their over-the-counter availability have led to the emergence of antibiotic resistance against prevalent infections worldwide [10]. Multidrug-resistant (MDR) uropathogens have become more common in both community and hospitalized patients during the past few years [11]. According to a study conducted by the European Survey of Antibiotic Consumption, MDR bacterial strains in complex UTIs cause over 25,000 deaths nationwide each year [12].

Therefore, it is crucial to prevent the improper and excessive use of antibiotics, which can result in multidrug resistance. Suitable medicines should be chosen for the empirical treatment of urinary tract infections. The pattern of antibiotic susceptibility among bacteria varies from hospital to hospital and within different geographical locations [13]. To track changes in antibiotic susceptibility trends, the Infectious Disease Society of America recommends conducting regional monitoring in a particular area [14]

In the current scenario, there is a rise in morbidity and mortality due to the alarming emergence of MDR bacterial infections and the frequent changes in antibiotic susceptibility patterns. Understanding the causative agents of urinary tract infections (UTIs) and their susceptibility to antibiotics is essential for both empirically treating UTIs and halting the development of antibiotic resistance. This study aimed to determine the prevalence of the UTI-causing pathogens, and their antimicrobial susceptibility pattern among individuals with suspected UTIs [15]

2. Methods

- Study design: Present study was prospective, observational, single centre study.
- Study centre and duration: Study was conducted on inpatient of General Medicine department at SH medical centre, Kottayam, Kerala for a period of 6 months.
- Study design: A total of 100 patient case records satisfying the inclusion criteria were analyzed to determine the prevalence of uropathogens causing UTI and also to determine antibiotic sensitivity pattern of uropathogens to various antibiotics.
- Inclusion criteria: Patients of either sex admitted in hospital with UTI. Also received at least one antibiotic for treating UTI.
- Exclusion criteria: Patients with negative culture report or having infection other than UTI. UTI caused by other than bacteria are excluded from our study.
- Procedure: All the relevant and necessary data of the patient were collected from patient's case record and microbiology department to study the antibiotic susceptibility pattern of uropathogens and also to study the rational prescribing of antibiotics before and after culture sensitivity test.

3. Results and discussion

3.1. A total of 100 patients were met with the inclusion criteria

Table 1 Frequency and percentage distribution according to age group

Age	Frequency (n)	Percentage (%)
<50	31	31
50 – 70	19	19
>70	50	50

It indicates that half of the UTI patients are over 70 years old The increased vulnerability to UTIs in this age group is caused by a number of factors, including hormonal changes, bladder dysfunction, catheter use, mobility challenges, chronic health disorders like diabetes mellitus kidney disease, and urine incontinence.

Table 2 Distribution of patients according to gender.

Gender	Frequency (n)	Percentage (%)
Female	53	53
Male	47	47

Based on this distribution, it may be inferred that a greater proportion of UTI patients are female (57%) than male (47%) for a variety of reasons, such as females shorter urethras and their close proximity to the anus, as well as hormonal changes during menstruation, pregnancy, and menopause.

Table 3 Frequency and percentage distribution according to type of organism N= 100

Organism	Frequency (n)	Percentage (%)
Gram – ve	83	83
Gram – ve	17	17

This distribution indicates that the majority of UTIs are caused by Gram-negative bacteria, which account for 83% of the cases, while Gram-positive bacteria are responsible for 17% of the cases. This suggests that Gram-negative bacteria are the predominant pathogens in UTI infections.

Table 4 Frequency and percentage distribution of uropathogens. N=100

Organism	Frequency (n)	Percentage (%)
Escherichia coli	41	41
Klebsiella pneumoniae	20	20
Pseudomonas aurogenosa	8	8
Beta hemolytic streptococci	7	7
Acinetobacter	6	6
Staphylococcus aureus	6	6
Citrobacter diversus	4	4
Citrobacter freundi	4	4
Non hemolytic streptococci	3	3
Alpha hemolytic streptococci	1	1

This indicates that *E. coli* was the most prevalent bacteria.

Table 5 Percentage distribution of antibiotics changed and not changed after C/S. N=100

Antibiotics	Frequency (n)	Percentage (%)
Changed after c/s	50	50
Not changed after c/s	50	50

The table indicates that 50% of the cases, the antibiotics were changed after conducting C/S. This suggests that the results of the C/S indicated a need to alter the antibiotic treatment. In the other 50% of the cases, the antibiotics were not changed after conducting C/S. This implies that the initial antibiotic treatment were appropriate based on the C/S results.

Table 6 Use of antibiotics pre and post C/S done

Class	Drug given to the patients		Frequency (n)
	BEFORE C/S	AFTER C/S	
1	Meropenem	Faropenem	4
2	Piperacillin tazobactum	Nitrofurantoin	3
2	Piperacillin tazobactum	Meropenem	3
2	Piperacillin tazobactum	Imipenem	3
3	Cefpodoxime	Cefotaxim	2
4	Moxifloxacin	Ceftriaxone	2
2	Piperacillin tazobactum	Faropenem	2
3	Ceftriaxone sulbactum	Imipenem	2
2	Piperacillin tazobactum	Cefpodoxime	2
3	Cefuroxime	Piperacillin tazobactum	2
2	Piperacillin tazobactum	Cefipime	2
3	Cefotaxim	Nitrofurantoin	1
3	Cefotaxim	Levofloxacin	1
5	Nitrofurantoin	Meropenem	1
1	Meropenem	Ampicillin	1
1	Imipenem	Ampicillin	1
3	Cefotaxim	Ciprofloxacin	1
3	Cefoperazone sulbactum	Ciprofloxacin	1
2	Piperacillin tazobactum	Cefotaxim	1
1	Meropenem	Linezolid	1
1	Imipenem	Faropenem	1
3	Cefuroxime	Ciprofloxacin	1
2	Piperacillin tazobactum	Ofloxacin	1
4	Ciprofloxacin	Ciprofloxacin	1
1	Faropenem	Nitrofurantoin	1

3	Ceftriaxone	Amoxiclav	1
6	Linezolid	Faropenem	1
1	Imipenem	Cefuroxime	1
3	Ceftriaxone	Ampicillin	1
5	Nitrofurantoin	Faropenem	1
3	Cefpodoxime	Piperacillin tazobactum	1
2	Piperacillin tazobactum	Ampicillin	1
4	Ciprofloxacin	Meropenem	1
7	Amikacin	Ceftriaxone	1

Table 7 Coding of Antibiotic class

Code	Antibiotic
1	Carbapenem
2	Penicillin
3	Cephalosporin
4	Quinolones
5	Nitrofuran
6	Oxazolidinedione
7	Aminoglycoside

Here, each class of antibiotic is assigned a code for identification purpose.

Table 8 Frequency and percentage distribution of class of antibiotics changed after C/S done. N= 50

Antibiotics	Frequency (n)	Percentage (%)
Carbapenem	10	20
Penicillin	18	36
Cephalosporin	14	28
Quinolones	4	8
Nitrofurantoin	2	4
Oxazolidinedione	1	2
Aminoglycoside	1	2

The table indicates that Penicillin is the most frequently changed antibiotic after culture sensitivity. This suggests that initial treatments involving these antibiotics are frequently adjusted after culture sensitivity results. This could imply a higher rate of resistance.

Table 9 Frequency and percentage distribution of class of antibiotic which replaced Penicillin after C/S done. N=18

Antibiotics	Frequency (n)	Percentage (%)
Nitrofuran	3	18
Carbapenem	8	44
Cephalosporin	5	28
Fluoroquinolones	1	5
Other type of penicillin	1	5

This data suggests that, most of the time carbapenem (44%) replaces penicillin after viewing C/S report followed by cephalosporin (28%), nitrofuran (18%), fluoroquinolones (5%) and other type of penicillin (5%).

Table 10 Statistical Analysis of antibiotics before and after culture and sensitivity done.

	Change in drug	No change in drug	Chi-square test
Before C/S	0	100	Chi-square=12.5
After C/S	50	50	P value = < 0.01

Statistical analysis was done using chi-squared test. The table shows a chi-square value of 12.25 with a p-value less than 0.001, signifying a statistically insignificant association. This shows that the drugs given before c/s and drugs given after c/s having a huge significant difference.

Table 11 Antibiotic Sensitivity Pattern Of Uropathogens

Antibiotics	Sensitive		Moderate sensitive		Resistant	
	Frequency(n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Cefuroxime	61	26	27	12	145	62
Ampicillin/sulbactam	186	80	1	0	46	20
Cefoperazone/sulbactam	131	56	44	19	58	25
Levofloxacin	109	47	19	8	105	45
Cefixime	76	33	23	10	134	57
Ceftriaxone	98	42	29	12	106	46
Sparfloxacin	104	45	20	8	109	47
Nalidixic acid	49	21	12	5	172	74
Ciprofloxacin	108	46	21	9	104	45
Furantoin	145	62	25	11	63	27
Cefotaxime	75	32	44	18	114	50
Meropenem	197	85	7	3	29	12
Cefipime	150	65	24	10	59	25
Tobramycin	151	65	24	10	58	25
Colistin	200	86	0	0	33	14
Gentamycin	157	67	23	10	53	23

Amikacin	169	72	25	11	39	17
Imipenem	202	87	10	4	21	9
Ofloxacin	106	45	20	9	107	46
Tetracycline	80	34	35	15	118	51
Cotrimoxazole	124	53	3	1	106	46
Norfloxacin	105	45	22	9	106	46
Ceftizoxime	95	41	21	9	117	50
Chloramphenicol	182	78	4	2	47	20
Piperacillin/tazobactam	89	38	85	37	59	25
Nithillin	195	84	6	2	32	14
Methicillin	9	4	1	0	223	96
Cephalexin	61	26	13	6	159	68
Lincomycin	20	9	0	0	213	91
Amoxicillin/clavulonic acid	69	30	20	8	144	62
Faropenem	74	32	2	1	157	67
Cefpodoxime	26	11	30	13	177	76
Ceftazidime	87	37	32	14	114	49
Tigecycline	168	72	43	18	22	10

This table shows antibiotics, such as Meropenem, Imipenem, and Colistin show high sensitivity rates indicating their effectiveness against most of the bacterial isolates.

4. Limitations

- Errors in laboratory practices, such as improper handling or incubation, can affect the results of susceptibility testing.
- Infections caused by multidrug-resistant pathogens complicate treatment choices and complicate the analysis of antibiotic effectiveness.
- Contamination of urine samples with commensal flora or external bacteria during collection or processing can result in false positive or misleading results.
- Factors like immune status, comorbid conditions, and prior antibiotic use can influence both the pathogen's resistance and the outcome of the infection, complicating the interpretation of susceptibility.
- Not all available antibiotics are tested, especially newer or less commonly used ones. This can lead to underestimation of the full range of effective treatment options.

5. Conclusion

The research evaluated the antibiotic sensitivity pattern of uropathogens that cause UTIs in 100 patients. Over 70-year-old make up 50% of UTI patients. Urinary tract infections (UTIs) are more common in this age group for a variety of reasons, including changes in hormones, bladder problems, catheter use, problems with mobility, and chronic illnesses like kidney disease, diabetes mellitus, and urine incontinence. The research population consists of 47% men and 53% women for a variety of reasons, including the shorter length of the female urethra and its close proximity to the anus, as well as hormonal changes that occur during menstruation, pregnancy, and menopause. Gram-negative bacteria cause 83% of UTI cases and Gram-positive bacteria cause 17% of cases. Gram-negative bacteria are the primary cause of UTIs. This implies that the majority of pathogens in UTI infections are Gram-negative bacteria. *E. coli was the mostfrequently isolated microorganism, followed by Acinetobacter, Pseudomonas aurogenosa, Beta haemolytic streptococci, and Klebsiella pneumoniae*. After conducting C/S, the antibiotics were changed in 50% of the cases. This implies that the C/S results required a modification in the antibiotic treatment. After performing C/S, the antibiotics were left unchanged in the remaining 50% of cases. This suggests that based on the C/S results, the initial antibiotic treatment was appropriate.

Inappropriate use of antibiotics is the primary cause of AMR and should be monitored. The proposed regulations from the Infectious Diseases Society of America state that patient history, drug accessibility, and geographic susceptibility data should all be taken into consideration when empirically treating UTIs with antibiotic. In India, bacterial uropathogen resistance is turning into a public health concern. Lack of suitable microbiological labs in many Indian cities and towns results in a higher empirical usage of antibiotics and less microbiological evaluations. Urine samples are usually sent for microbiological testing only in cases of recurrent or relapsing infections or treatment failure. Our results highlight the importance of local patterns of antibiotic resistance, which can then be utilized to inform regional and hospital antibiotic policy.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

The study was approved by the Institutional Ethics Committe

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