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**Original Research Article**

# A prospective study on antibiotic resistance pattern in patients with urinary tract infection

**Swastika Raj Singh*, Shibi Mary Thomas, Balakeshwa Ramaiah**

Department of Pharmacy Practice, Karnataka College of Pharmacy, Karnataka, India

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***Correspondence:**
Swastika Raj Singh,
Email: swastika.singh7777@gmail.com



## ABSTRACT

**Background**: Antibiotics are a blessing to the mankind in the realm of medical treatment. Quite contrary to that fact, they may cause risks in medical treatments of patients if these antibiotics are not taken under medical guidelines. In the current scenario it is a huge challenge for selecting appropriate antibacterial agents for the treatment of UTI. This study aims to evaluate the prescription & resistance pattern of antibiotics in patients with urinary tract infection.
**Methods:** A prospective observational study was carried out for a period of 1 year. Data on 100 research participants' reports and the results of their tests for antibiotic resistance were taken from the microbiology department's records, evaluated, and represented as percentages. Observations were made and meticulously recorded.
**Results:** Out of 100 study participants, *Escherichia coli* was the most common pathogen with a total of (35%) followed by *Klebsiella* (17%), *Enterococcus* with (16%). *E. coli* were highly resistant to Ampicillin (88.6%) and Cefazolin (88.6%), Ceftraixone (85.3%). *Klebsiella* were highly resistant to Ampicillin (100%) Cefazolin (93.3%), Cefuroxime (85.7%). *Enterococcus* were highly resistant to Tetracycline (92.9%) Ciprofloxacin (85.7%), Levofloxacin (81.8%). Where, *E. coli* were highly sensitive to Amikacin, Imipenem, Ertapenam. *Klebsiella* were highly sensitive to Meropenem, Cefoperazone/Sulbactam, Amikacin. *Enterococcus* was highly sensitive to Linezolid, Teicoplanin, Vancomycin.
**Conclusions:** Most of the identified bacteria were resistant to several of the popular antibiotics used in clinical settings. Consequently, it is vital to prescribe antibiotics rationally both before and after culture reports.

**Keywords:** Antibiotics, Pathogen, Resistant, Sensitive, Culture

## INTRODUCTION

In both community and hospital-acquired infections, urinary tract infection (UTI) is a prevalent health concern. It is one of the most frequent infections, especially among women.[1] It is described with the presence of bacteria in the urine as well as symptoms related to the urinary tract such frequent urination, urgency, and occasionally suprapubic discomfort. As women have a shorter, straighter, and broader urethra than men, it is common in women. The treatment of UTIs frequently involves the use of broad-spectrum antibiotics when a narrow-spectrum antibiotic would have been adequate. This situation follows the "blanket" use of antibiotics, which has become a significant global problem in recent years.[2] A significant public health concern is the development of antibiotic resistance in the treatment of UTIs. Fake and counterfeit pharmaceuticals of uncertain quality are widely available, especially in the developing countries where there is a high degree of poverty, illiteracy, and inadequate hygiene practices. Drug misuse is a possibility because of the inexpensive price and simple community access to the medications without a prescription. Dearth of microbiology laboratory support adds to the challenge.

Moreover, the nature and pattern of antimicrobial prescribing practice changes with time as spectrum of pathogens change and new antimicrobials are introduced.[3-14] Culture sensitivity tests were also important in case of UTI to go for a specific antibiotic treatment rather than the empirical treatment for the patients.[15,16] Ideally, the antimicrobial agent chosen should be well tolerated, well absorbed, achieve high urinary concentrations, and have a spectrum of activity limited to the known or suspected pathogen(s).[17,18] Bacterial strains, even from the same species, may vary widely in sensitivity to antibiotics. Information about the antibiotic sensitivity of the infecting microorganism is important for appropriate drug selection. Various methods are used to assess susceptibility, including disk-diffusion, dilution test, and automated broth dilution. The results are either reported on a semi-quantitative scale (i.e., resistant, intermediate, or susceptible) or in terms of the minimal inhibitory concentration (MIC).[19] Single-dose therapy is used frequently, although it can be associated with lower cure rates and increased reoccurrence compared with longer therapies.[17] The dose and dosing frequency of antibiotics traditionally have been selected to achieve antibacterial activity at the site of infection for most of the dosing interval. This may not always be necessary, and superior results may even be obtained with high peak concentrations followed by periods of sub inhibitory activity.[19]

Antibiotic resistance has been primarily proven to occur as a result of uncontrolled and widespread antibiotic use. Antimicrobial resistance surveillance forms the link between testing and treatment guidelines, which are often provided by different kinds of agencies. It is very much evident that antimicrobial resistance has been increasing at an alarming rate throughout the world with the appearance of more extended spectrum beta-lactamase (ESBL) infections. World Health Organization's global plan of action on AMR has stressed antimicrobial resistance surveillance across nations as an important strategy for reducing AMR.[5] Antibiotic resistance can be a problem when some bacteria continue to grow and are able to infect the body even after a person has taken antibiotics. It is less sensitive to possible treatment options and more difficult to remove. Many ESBL (Extended spectrum beta lactamase)-producing bacteria are multiresistant to non-β-lactam antibiotics too, such as quinolones, aminoglycosides and trimethoprim, narrowing treatment options. Since ESBL- E. coli tends to be pathogenic, a large percentage of infections conclude in bacteraemia and subsequent fatality. Some strains cause outbreaks both in hospitals and in the community.[18] Different countries have different patterns of bacterial sensitivity to antimicrobials. Antibiotics should not be used carelessly since this promotes the development of antimicrobial resistance; instead, the most suitable antibiotics should be used as the first line of therapy for UTI. In the current scenario, where the antimicrobial resistance pattern is changing very alarmingly and new MDR bacteria are emerging frequently leading to enhance morbidity and mortality.[1] High mortality, morbidity, and expense are challenges brought on by the antibiotic resistance of the bacterial isolates of UTI.[7] The criteria for the selection of antimicrobial medications should be established on the basis of the most likely infections and its predicted resistance pattern in a geographic region, as the majority of UTIs are treated empirically.[16]

Successful antimicrobial therapy of an infection ultimately depends on the concentration of the antibiotic at the site of infection, which must be sufficient to inhibit growth of the offending microorganisms. Drug concentrations must inhibit the organism at the infection site while yet being below levels dangerous to human cells. If this can be achieved, the microorganism is considered sensitive; if not, the microorganism is considered resistant to the drug. The achievable serum concentration for an antibiotic generally is used to guide decisions on sensitivity or resistance of a microorganism to that drug.[19] This study aims to evaluate the prescription & resistance pattern of antibiotics in patients with urinary tract infection.

## METHODS

In the department of medicine, a prospective and observational study was done for a period of 1 year in a tertiary care hospital in Karnataka, India. Patients who matched the eligibility requirements were enrolled in the study. Prescriptions from inpatient sheets were examined on a daily basis for assessing medications prescribed and antibiotic resistance patterns. Patients who were being treated with antimicrobials for a urinary tract infection were recorded.

Later, the culture/sensitivity reports were cross-checked from hospital's computer system. Data collecting forms were used to review and document medication charts. Demographics, diagnosis, co-morbidities, medical history, drugs administered (dose, route, frequency, therapy, duration, indication), laboratory investigation, and presenting complaints were among the information gathered. The start date of antibiotics, empirical therapy, and sample collection date for culture and sensitivity test, resistant antibiotics, antibiotic changes, limited antibiotics, and adverse drug responses were all included. To evaluate the prescription and patient chart, the reference projects and books were used as tools. The patients were examined again for infection improvement, with their condition being closely monitored until they were discharged. The data included associated antibiotic resistance test results, patient personal information, and all antibiotics used in urinary tract infections dispensed before and after the resistance testing. The data were compiled using acceptable statistical procedures in an excel file.

A straightforward percentage approach was used to do and display all of the analyses. The research participants' anonymity and privacy were maintained.

## RESULTS

Total 100 patients met the eligibility requirements for the study to be carried out at a tertiary healthcare facility in the year 2022 timeframe.

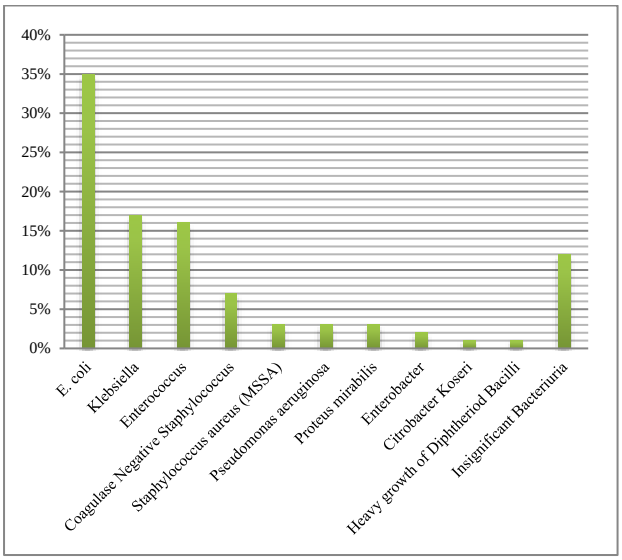


**Figure 1: Bacterial pathogens found in culture sensitivity test.**

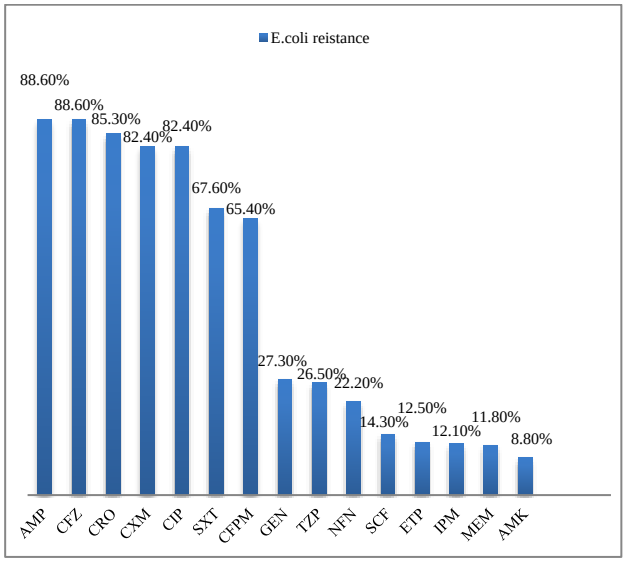


**Figure 2: Escherichia coli resistance pattern.**

AMP - Ampicillin, CFZ - Cefazolin, CRO - Ceftriaxone, CXM - Cefuroxime, CIP - Ciprofloxacin, SXT - Cotrimoxazole, CFPM - Cefipime, GEN - Gentamicin, TZP - Piperacillin/Tazobactam, NFN - Nitrofurantoin, SCF - Cefoperazone/Sulbactam, ETP - Ertapenam, IPM - Imipenem, MEM - Meropenem, AMK - Amikacin.

88% of the 100 study participants had bacterial growth, compared to 12% who had none. In the study of population's gender distribution, 24% of the patients were found to be male and 76% to be female. Among 100 culture isolates, *E. coli* was the most common among 35% patients, and then *Klebsiella* among 17%, *Enterococcus* among 16%, and so on. The frequency of bacterial infections discovered in the culture sensitivity test (c/s) is displayed in the (Figure 1).

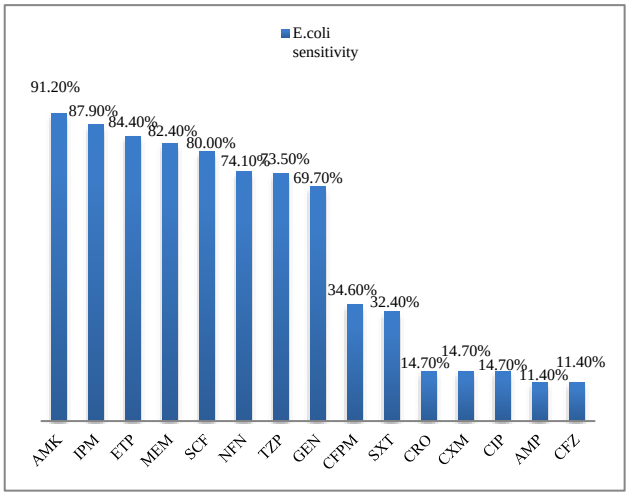


**Figure 3: *Escherichia coli* sensitivity pattern.**

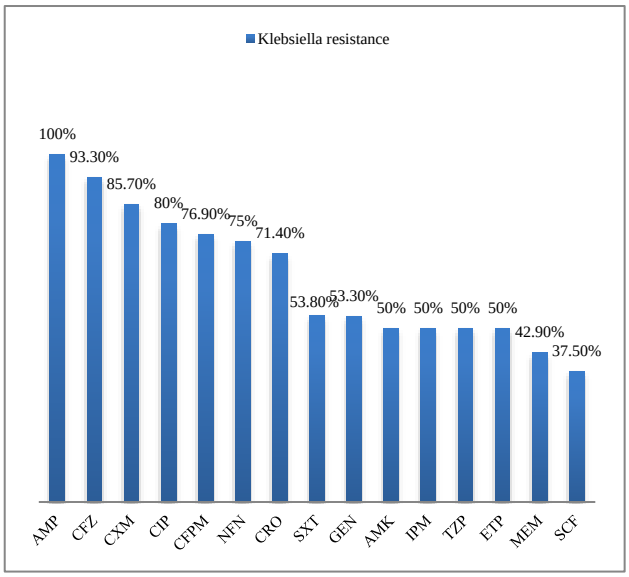


**Figure 4: *Klebsiella* resistance pattern.**

The majority of the bacteria were gram negative bacilli, numbering 61, followed by gram positive cocci, numbering 23, then gram positive bacilli, numbering 4, and finally 12 people with insignificant bacteriuria. Few adverse reactions were seen in patients resulting in rashes all over the back and vomiting one being allergic to Cefoperazone/Sulbactam; second to Ceftriaxone; and third to Dapsone. Both antibiotic sensitivity as well as resistance patterns was monitored carefully. Numerous organisms and their resistance pattern in percentage were included in the analysis. However, resistance patterns for *E. coli* and *Klebsiella* are illustrated as they were the majority isolated uropathogens. *E. coli* were extremely resistant to Ampicillin (88.6%) and Cefazolin (88.6%), followed by Ceftraixone (85.3%), Cefuroxime (82.4%), Ciprofloxacin (82.4%), Cotrimoxazole (67.6%), Cefipime (65.4%),

Gentamicin (27.3%), Piperacillin/Tazobactam (26.5%), Nitrofurantoin (22.2%), Cefoperazone/Sulbactam (14.3%), Ertapenam (12.5%), Imipenem (12.1%), Meropenem (11.8%), Amikacin (8.8%). The data is illustrated in (Figure 2).

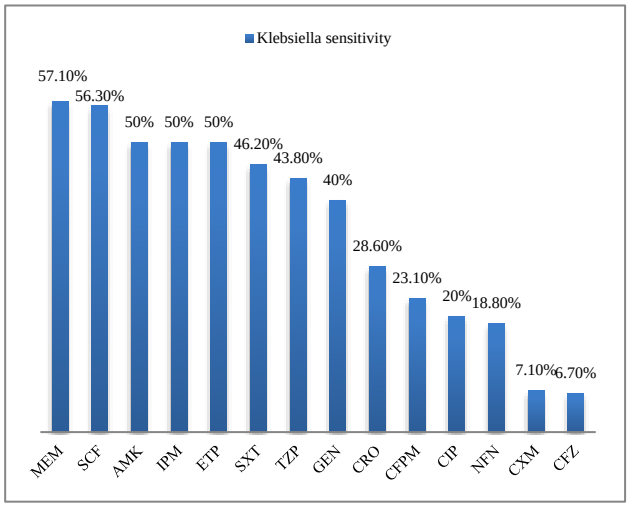


**Figure 5: *Klebsiella* sensitivity pattern.**

*E. coli* were found to be sensitive to Amikacin (91.2%) followed by Imipenem (87.9%), Ertapenam (84.4%), Meropenem (82.4%), Cefoperazone/Sulbactam (80%), and Nitrofurantoin (74.1%), Piperacillin/Tazobactam (73.5%), Gentamicin (69.7%), Cefipime (34.6%), Cotrimoxazole (32.4%), Ceftriaxone (14.7%), Cefuroxime (14.7%), Ciprofloxacin (14.7%), Ampicillin (11.4%), Cefazolin (11.4%). The data is illustrated in (Figure 3).

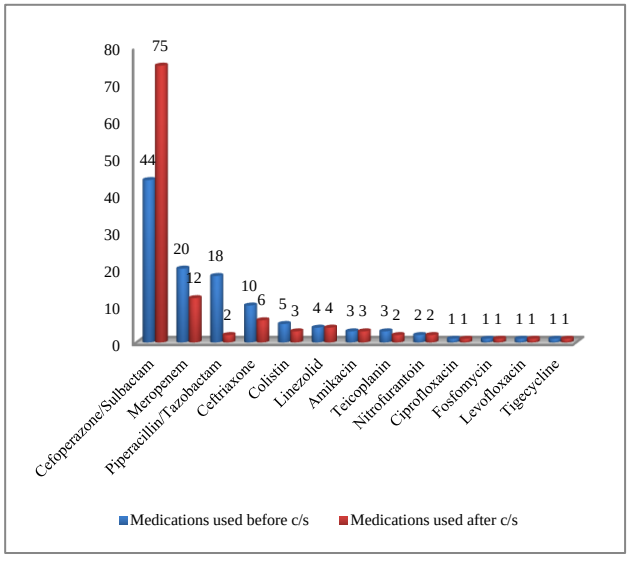


**Figure 6: Drugs assessment after culture sensitivity test.**

*Klebsiella* were extremely resistant to Ampicillin (100%) followed by Cefazolin (93.3%), Cefuroxime (85.7%), Ciprofloxacin (80%), Cefipime (76.9%), Nitrofurantoin (75%), Ceftriaxone (71.4%), Cotrimoxazole (53.8%), Gentamicin (53.3%), Amikacin (50%), Imipenem (50%), Piperacillin/Tazobactam (50%), Ertapenam (50%), Meropenem (42.9%), Cefoperazone/Sulbactam (37.5%). The data is illustrated in (Figure 4). *Klebsiella* were found to be sensitive to Meropenem (57.1%) followed by Cefoperazone/Sulbactam (56.3%), Amikacin (50%), Imipenem (50%), Ertapenam (50%), and Cotrimoxazole (46.2%), Piperacillin/Tazobactam (43.8%), Gentamicin (40%), Ceftriaxone (28.6%), Cefipime (23.1%), Ciprofloxacin (20%), Nitrofurantoin (18.8%), Cefuroxime (7.1%), Cefazolin (6.7%). The data is illustrated in (Figure 5). Few drugs were replaced after the culture sensitivity test; for some, dose was increased, although the same antibiotics used for UTI were provided to most of the participants. (Figure 6) compares the medications prescribed before and after the c/s test.

## DISCUSSION

Antibiotics are intended to use to prevent or cure diseases but anytime use, use of antibiotics without physicians' prescriptions, and in many other situations, they have contrary effects. Antibiotic resistance can be exacerbated by the usage of antibiotics. Antimicrobial resistance is caused by a combination of antibiotic-exposed bacteria and the spread of those bacteria and the irresistance mechanisms. The advantages of using antibiotics often exceed the hazards of antibiotic resistance. However, too many antibiotics are unnecessarily used or misused to undermine the usefulness of this important medicines.[3-4]

Anyone, at any stage of life, can be impacted by antibiotic resistance. People who have medical care or who have a weakened immune system are often at increased risk of infection. Antibiotic resistance threatens the modern medical advances we rely on, such as joint replacement surgery, organ transplantation, and cancer treatment. Patients cannot receive treatment if they do not receive effective antibiotics.[11-12] The majority of pharmaceutical firms are no longer developing new antibiotics. Half of all antibiotics in use today were discovered in the 1950s. Since then, antibiotic discovery and development has become more complex, time-consuming and expensive. Newly approved antibiotics typically have short treatment durations and limited use to slow the emergence and spread of resistance. This limits profitability. Even when new antibiotics become available, they rarely target drug-resistant bacteria and are approved for use in only a few countries. Of the 25 new antibiotics launched between 1999 and 2014, only 12 of these were approved in more than 10 countries.[10-11] Nearly 9/10 patients with drug-resistant *E. coli* infections improved when given the antibiotic Imipenem, which was prescribed in 2016, but it was found, after 6 years, working only on about 6/10 patients. Over the years, various strains of bacteria have adapted to drugs that would normally kill them, allowing them to fight the drugs. These bacteria, sometimes referred to as superbugs, keep multiplying and causing illnesses even after being treated with a variety of medications. Antibiotics may not work.[6-8] People with other underlying

conditions that weaken the immune system, either as a result of the disease or as a side effect of current treatments, are often at the highest risk of antibiotic-resistant infections. They are often already on antibiotics or hospitalized. Senior citizens, nursing homes or people undergoing catheterization may also be affected by persistent or recurrent resistant UTI. The biggest risk is that untreated or resistant infections can lead to kidney problems and more serious illness.[9]

Ahmed et al conducted a study in Qassim University and concluded that multidrug-resistant bacteria can lead to momentous therapeutic problems in OPD patients. This study was conducted on 273 urine samples collected from outpatient departments. Of 273 urine samples, only 89 (32.6%) were found to show significant growth for UTI, and overall, drug resistance was found in 92% of samples, with most (80%) being resistant to at least two drugs. Antibiotic resistance was commonly observed in ampicillin (88.3%), piperacillin (72.7%), clindamycin (66.7%), amoxicillin/clavulanic acid (66.2%), and trimethoprim/sulfamethoxazole (50%). The commonly isolated microorganisms were Escherichia coli 24 (27%), Klebsiella pneumoniae 11 (12.4%), Proteus mirabilis 4 (4.5%), Pseudomonas aeruginosa 4 (4.5%), Enterobacter cloacae 5 (5.6%), Enterococcus faecalis 5 (5.6%), and Staphylococcus saprophyticus 3 (3.4%). This research work had shown that patients with UTI in Qassim were at high risk of antibiotic resistance.[1] Mallam et al conducted a study and showed that the majority of the isolated bacteria were resistant to many antibiotics commonly used in clinical practices. In this study, they aimed to evaluate the spectrum and antibiotic resistance pattern of uropathogens and to provide a basis for appropriate antimicrobial therapy in patients with UTI). A total of 282 positive urine cultures, non-repetitive samples during the study period were included. Hence, they concluded prior culture reports and institutional antibiograms are necessary for prescribing antibiotics rationally.[2] It is possible to investigate brand-new antimicrobial stewardship techniques that may reduce resistance in urinary tract infections. Multidrug resistance can be completely researched in depth with a larger number of participants. Errors occurred due to the prescriptions' readability, which might be prevented in upcoming research projects. The researcher's point of view is dissatisfied due to a lack of detailed information about the disease and a lack of information about the patients' status after being discharged from the hospital. All types of UTI were considered as study limitations. It can be a drawback. It would have been better if the UTI was differentiated for the analysis into both complicated and uncomplicated. Here, other limitation was short study period. Indication of multiple drugs in UTI was noted despite being resistant to the organisms. Therefore, in the future, it will be possible to depict medications that have been identified as resistant but are nevertheless provided following a culture sensitivity test, which will shorten patients' stay in hospitals. It is advantageous for the patient's health to administer medications that are discovered to be sensitive to particular organisms.

## CONCLUSION

Most of the identified bacteria were resistant to several of the popular antibiotics used in clinical settings. Consequently, it is vital to prescribe antibiotics rationally both before and after culture reports.

### *Recommendations*

Amikacin and tobramicin are not significantly different and that such toxicities are indeed infrequent events. The difference in our results with those obtained by others could be attributed to the differences in the baseline clinical characteristics between the studied groups or differences in the methodology applied, particularly the definition of nephrotoxicity.

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