Print ISSN: 2321-6379
Online ISSN: 2321-595X
DOI: 10.17354/ijss/2017/65

Original Article

A Study on Urinary Tract Infection Pathogen Profile and Their *In Vitro* Susceptibility to Antimicrobial Agents

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Abstract

Introduction: Urinary tract infection (UTI) is a worldwide common bacterial infection, and it is important to know the common organisms and its antibiotic resistance pattern in our practicing locality, to guide us in instituting treatment.

Aims and Objectives: (1) To analyze and statistically evaluate the distribution of common organisms causing UTI in the community. (2) To investigate the antibiotic sensitivity pattern of the common organisms causing UTI. (3) To study the distribution of UTI among different age groups and gender. (4) To compare the sensitivity and resistance of oral with parenteral antibiotic.

Materials and Methods: This was an observational study over a period of 5 months, which consisted of consecutively selected patients, more than 18 years of age, visiting Sri Ramachandra Medical College and Hospital, Porur, either as outpatients or inpatients, with symptoms of UTI and with positive urinary cultures with significant colony count. Pregnant patients, patients on catheter, those with insignificant colony count and patients who were treated with antibiotics for the current complaint of UTI were excluded.

Results: The prevalence of *Escherichia coli* was the highest (59.4%), followed by *Klebsiella pneumoniae* (14.2%) and *Enterococcus faecalis* (11.4%). *E. coli* was most sensitive to nitrofurantoin among oral antibiotics (96.1%) and amikacin among parenteral antibiotics (98.4%), followed by piperacillin-tazobactam (97.7%) and cefoperazone-sulbactam (93.7%). *K. pneumoniae* was most sensitive to nitrofurantoin (64.3%), followed by norfloxacin (61.3%) among oral antibiotics and amikacin (93.5%), followed by piperacillin-tazobactam (90.3%) and cefoperazone-sulbactam (83.9%) among parenteral antibiotics.

Conclusion: This study was aimed at finding out the common organism causing UTI and its sensitivity pattern in our practicing locality. It is concluded that *E. coli* and *K. pneumoniae* were the common organisms and both were most sensitive to nitrofurantoin among oral antibiotics and amikacin among parenteral antibiotics.

Key words: Antibiotic sensitivity pattern, *Escherichia coli*, *Klebsiella pneumoniae*, Oral and parenteral antibiotic, Urinary tract infection

INTRODUCTION

Urinary tract infection (UTI) is among the most common bacterial infection and account for a significant part of the out-patient and in-patient department patients. In the pre-antibiotic era, UTI caused significant morbidity. Hippocrates, when describing a disease that appears to be acute cystitis, said that the illness could last for a year before either resolving or worsening. Nitrofurantoin, which became available in the 1950s, was the first effective antibiotic for the treatment of UTI. The most common manifestation of UTI is acute cystitis, and it is far more prevalent among women than among men, hence most clinical research on UTI has involved women. The available data demonstrate *Escherichia coli* as the most common organism responsible

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Month of Submission : 12-2016
Month of Peer Review : 01-2017
Month of Acceptance : 01-2017
Month of Publishing : 02-2017

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for UTI, and there is a worldwide increase in the resistance of *E. coli* to antibiotics commonly used to treat them. North American and European surveys from females with acute cystitis have documented resistance rates of >20% to trimethoprim-sulfamethoxazole and ciprofloxacin.[1] In community-acquired infections, there is an increase in the prevalence of uro-pathogens producing extended-spectrum β-lactamases leaving only few oral antibiotic options for therapy. Since resistance rates vary in each geographic region, with individual patient characteristics, it is important to know the current and local data when choosing an empirical treatment regimen.

This study was designed to find the distribution of common organisms causing UTI in males and females, who presented to Sri Ramachandra Medical College and Hospital, Porur, Chennai, with urinary tract symptoms, and to determine the antibiotic susceptibility pattern of microbial organisms isolated from the urine culture, to help in the empirical treatment and reduce antibiotic resistance.

Aims and Objectives

1. To analyze and statistically evaluate the distribution of common organisms causing UTI in the community.
2. To investigate the antibiotic sensitivity pattern of the common organisms causing UTI in adult patients.
3. To study the distribution of UTI among different age groups and compare the same between male and female.
4. To compare the sensitivity and resistance of oral with parenteral antibiotic.

MATERIALS AND METHODS

This was an observational study, which consisted of consecutively selected patients visiting Sri Ramachandra Medical College and Hospital, Porur, Chennai, either as outpatients or admitted as in-patients, over a period of 5 months, from April 2016 to September 2016.

Selection Criteria for Cases

1. Hospital-based patients (in-patients and out-patients) visiting Sri Ramachandra Medical College and Hospital, Porur, Chennai, from April to September 2016, with symptoms of UTI.
2. Age more than 18 years.
3. Patients with positive urine cultures with significant colony count (>10^5) were included in the study.

Exclusion Criteria for Cases

1. Pregnant patients were excluded.
2. Patients on catheter were excluded.
3. Patients with urine culture showing <10^5 colony count.
4. Patients who were treated with antibiotics for the current complaint of UTI.

Methodology

Patient information was collected with the help of a questionnaire after obtaining informed consent. It included details like age, gender, diabetic profile, pregnancy status, use of catheters, recent use of antibiotics for the current complaint of UTI, etc. Clean catch mid-stream urine samples were collected for culture and sensitivity in all patients presenting with symptoms of UTI. Antimicrobial susceptibility was done by Kirby Bauer's disc diffusion method. Data was entered in Microsoft Excel spreadsheet and analyzed statistically using Statistical Package for the Social Science system. Significance testing of the difference between means was performed by Chi-square test, and correlations were assessed by Pearson coefficient. Significance was considered, if the "*P*" value was below 0.05.

RESULTS

Our study group included 219 patients with positive urine cultures with a significant colony count of equal to or >10^5.

Age Distribution

Nearly 45.2% of the patients were in the age group 40-60 years. The minimum age in the study group was 18 years, and maximum was 98 years (Table 1 and Figure 1).

Table 1: Age distribution

Valid (***n***)	219
Missing	0
Mean	51.35
Median	51.00
Mode	55
SD	17.190
Min	18
Max	98

SD: Standard deviation

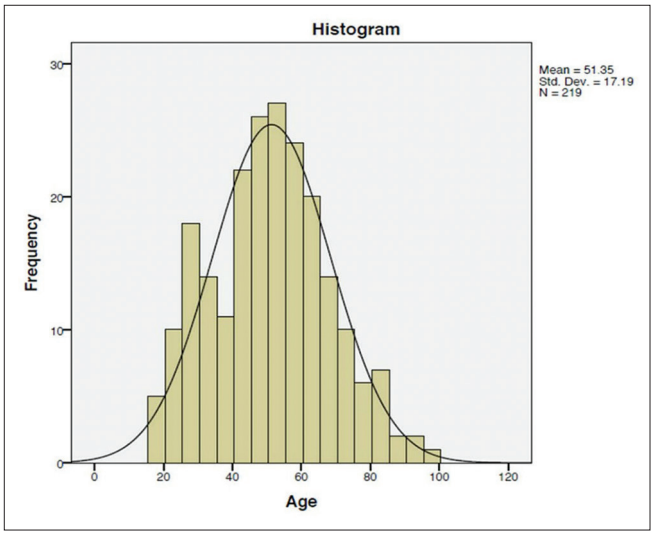

Figure 1: Age distribution

Sex Distribution

Out of the 219 patients who were included in the study, 111 patients were male, which comprised 50.7% and 108 patients were female, which comprised 49.3% (Figure 2).

Diabetic Profile

While comparing the diabetic profile for our study group, 37.9% were diabetics, and 62.1% were non-diabetics (Figure 3).

Sex Distribution within Diabetic Profile

In the diabetic group, male population was predominant (53%) when compared with females (47%). In the non-diabetic population, female population was predominant (50.7%) when compared with males (49.3%) (Figure 4).

Distribution of Organisms Causing UTI in this Study

While studying the pattern of organisms grown in the urine, we noticed that the prevalence of *E. coli* was the highest. 130 out of 219 patients (59.4%) grew *E. coli* in their culture, followed by *Klebsiella pneumonia* (31 out of 219 patients [14.2%] were positive), 25 out of 219 patients (11.4%) were positive for *Enterococcus faecalis*, 5% were positive for *Acinetobacter* species, 3.7% were positive for *Staphylococcus* species, 1.8% were positive for *Enterobacter* species and *Pseudomonas aeruginosa* each, 0.9% were positive for *Providencia* species and *Morganella* species each, 0.5% were positive for *Streptococcus* species and *Proteus mirabilis* each (Table 2 and Figure 5).

Table 2: Distribution of organisms causing UTI in this study

S. No	Organisms	Frequency of occurrence (%)
1	*Escherichia coli*	130 (59.4)
2	*Klebsiella pneumoniae*	31 (14.2)
3	*Enterococcus faecalis*	25 (11.4)
4	*Acinetobacter*	11 (5.0)
5	Coagulase negative *Staphylococcus*	5 (2.3)
6	*Enterobacter*	4 (1.8)
7	*Pseudomonas aeruginosa*	4 (1.8)
8	*Staphylococcus aureus*	3 (1.4)
9	*Morganella*	2 (0.9)
10	*Providencia*	2 (0.9)
11	*Proteus mirabilis*	1 (0.5)
12	*Streptococcus* species	1 (0.5)

UTI: Urinary tract infection

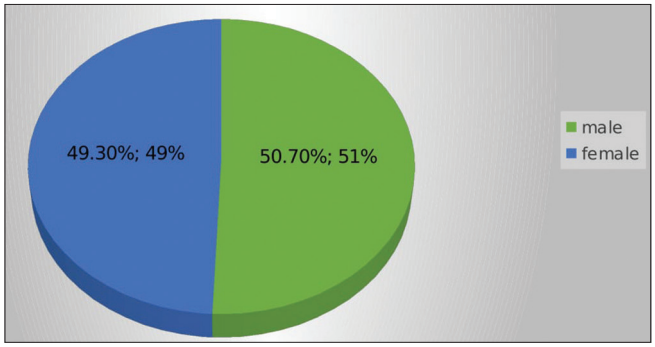

Figure 2: Sex distribution

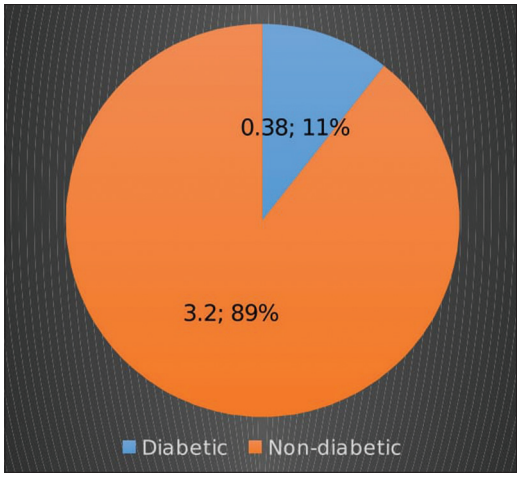

Figure 3: Diabetic profile

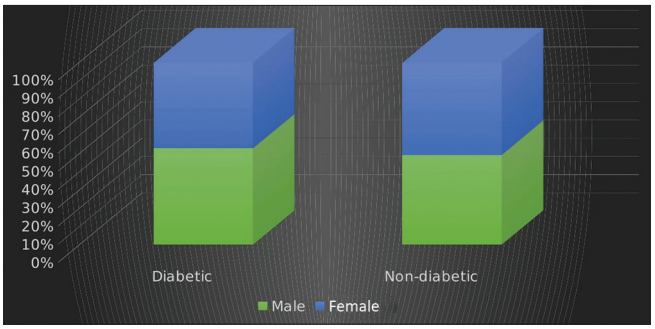

Figure 4: Sex distribution within diabetic profile

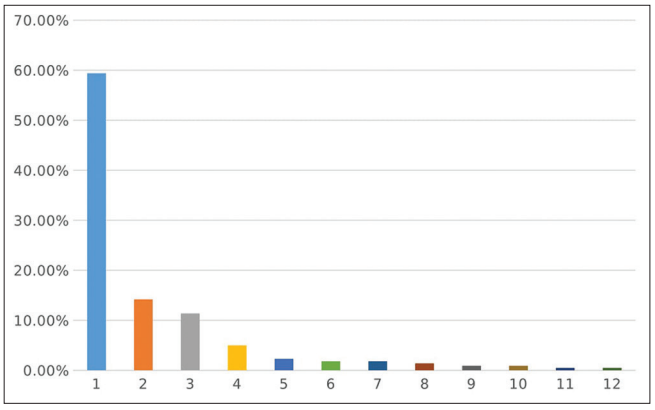

Figure 5: Distribution of organisms causing urinary tract infection in this study. 1 - *Escherichia coli*, 2 - *Klebsiella pneumoniae*, 3 - *Enterococcus faecalis*, 4 - *Acinetobacter*, 5 - Coagulase negative *Staphylococcus*, 6 - *Enterobacter*, 7 - *Pseudomonas aeruginosa*, 8 - *Staphylococcus aureus*, 9 - *Morganella*, 10 - *Providencia*, 11 - *Proteus mirabilis*, 12 - *Streptococcus* species

Sensitivity Pattern of the Oral (O) and Parenteral (P) Antibiotics Used in this Study

All 219 patients were tested for ampicillin in which 13.7% were sensitive and 86.3% were resistant. Out of the 98.2% who were tested for cefotaxime 33.5% were sensitive and 66.5% were resistant. Nitrofurantoin was tested in 95.4% patients, out of which 82.3% were sensitive. Out of the 219 patients, 85.4% patients were tested for piperacillin-tazobactam and 95.2% were sensitive, and only 4.8% were resistant. Norfloxacin was tested in 84.9% out of which 55.9% were sensitive. Amikacin was tested in 84% in which 95.1% were sensitive. 83.6% were tested for cotrimoxazole and cefoperazone-sulbactam each, out of which the sensitivity percentage was 45.9% and 90.7%, respectively. Other drugs such as ciprofloxacin, imipenem, polymyxin, tobramycin, linezolid, and vancomycin were tested in less than 15% of the study population, in which polymyxin and linezolid were sensitive in all the patients tested (Table 3).

Oral versus Parenteral Antibiotics

On comparing the sensitivity pattern for oral antibiotics, out of 219 patients, 201 (91.8%) were sensitive to at least one oral antibiotic and 18 (8.2%) were resistant to all oral antibiotics.

Similarly, out of 219 patients tested for parenteral antibiotics, 217 (99.1%) were sensitive to at least one parenteral antibiotics, and 2 (0.9%) were resistant to all parenteral antibiotics. But the relation was not significant (Chi-square test *P* value 0.671) (Figure 6).

Oral versus Parenteral Antiobiotic Sensitivity Based on Age Distribution

On grouping the patients into 3 groups, based on their respective ages, 26.5% were in the age group of 18-40 years, 45.2% in 40-60 years of age and 28.3% in the age group above 60.

In the first group, 93.1% were sensitive to at least one oral antibiotic, 98.3% were sensitive to at least one parenteral antibiotic, 6.9% were resistant to all oral antibiotics, and 1.7% were resistant to all parenteral antibiotics.

In the age group between 40 and 60 years of age, 91.9% were sensitive to at least one oral antibiotic, 99% were sensitive to at least one parenteral antibiotic, 8.1% were resistant to all oral antibiotics and 1% was resistant to all parenteral antibiotics.

In the age group above 60 years, 90.3% were sensitive to at least one oral antibiotic, 100% were sensitive to at least one parenteral antibiotic and 9.7% were resistant to all oral antibiotics (Figures 7 and 8).

E. coli Sensitivity Pattern to Commonly Used Antibiotics

We did an extensive study of the sensitivity and resistance pattern of the two common organisms grown in the urine culture in our study population, *E. coli* and *K. pneumoniae*, and compared their antibiotic sensitivity pattern with that of other organisms (Tables 4 and 5).

From Table 5, it is seen that *E. coli* was most sensitive to nitrofurantoin among oral antibiotics (96.1%) and

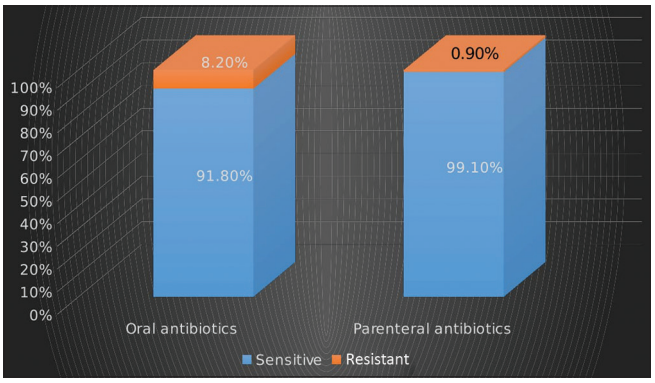

Figure 6: Oral versus parenteral antibiotics

Table 3: Sensitivity pattern of the oral (O) and parenteral (P) antibiotics used in this study

S. No	Antibiotic	Tested in	Tested in (%)	Sensitive in	Sensitivity (%)	Valid sensitivity (%)
O1	Nitrofurantoin	209	95.4	172	78.5	82.3
O2	Cotrimoxazole	183	83.6	84	38.3	45.9
O3	Norfloxacin	186	84.9	104	7.5	55.9
O4	Ciprofloxacin	32	14.6	24	10.9	75
IV1	Ampicillin	219	100	30	13.7	13.7
IV2	Amikacin	184	84	175	79.9	95.1
IV3	Cefoperazone-sulbactam	183	83.6	166	75.8	90.7
IV4	Cefotaxime	215	98.2	72	32.9	33.5
IV5	Imipenem	8	3.7	5	2.3	62.5
IV6	Piperacillin-tazobactam	187	85.4	178	81.3	95.2
IV7	Polymyxin B	7	3.2	7	3.2	100
IV8	Tobramycin	11	5	5	2.3	45.5
IV9	Linezolid	12	5.5	12	5.5	100
IV10	Vancomycin	12	5.5	11	5.0	91.7

Table 4: Comparison of sensitivity pattern of antibiotics between *E. coli* and other organisms

Antibiotics	*E. coli* positive	*E. coli* negative	Total	*P* value
Nitrofurantoin				
Resistant	5	32	37	0.0005
Sensitive	124	48	172	
Cotrimoxazole				
Resistant	72	27	99	0.472
Sensitive	57	27	84	
Norfloxacin				
Resistant	59	23	82	0.339
Sensitive	68	36	104	
Ciprofloxacin				
Resistant	1	7	8	0.078
Sensitive	0	24	24	
Ampicillin				
Resistant	116	73	189	0.128
Sensitive	14	16	30	
Amikacin				
Resistant	2	7	9	0.001
Sensitive	127	48	175	
Cefoperazone-sulbactam				
Resistant	8	9	17	0.031
Sensitive	120	46	166	
Cefotaxime				
Resistant	88	55	143	0.5
Sensitive	41	31	72	
Imipenem				
Resistant	1	2	3	0.8
Sensitive	2	3	5	
Piperacillin-tazobactam				
Resistant	3	6	129	0.01
Sensitive	126	52	58	
Polymyxin				
Resistant	0	0	0	-
Sensitive	2	5	7	
Tobramycin				
Resistant	2	4	6	0.05
Sensitive	2	3	7	
Linezolid				
Resistant	0	0	0	-
Sensitive	0	12	12	
Vancomycin				
Resistant	0	1	1	-
Sensitive	0	11	11	

E. coli: Escherichia coli

amikacin among parenteral antibiotics (98.4%), followed by piperacillin-tazobactam (97.7%) and cefoperazone-sulbactam (93.7%). Polymyxin was tested only in 2 patients, and it was sensitive in both these patients (Table 6 and Figure 9).

K. pneumoniae Sensitivity Pattern to Commonly Used Antibiotics

From Table 7, it is seen that *K. pneumoniae* was most sensitive to nitrofurantoin among oral antibiotics (64.3%), followed by norfloxacin (61.3%) and cotrimoxazole (58.1%). Among the parenteral antibiotics, *K. pneumoniae* was most sensitive to amikacin (93.5%), followed by piperacillin-tazobactam (90.3%) and cefoperazone-sulbactam (83.9%). Imipenem

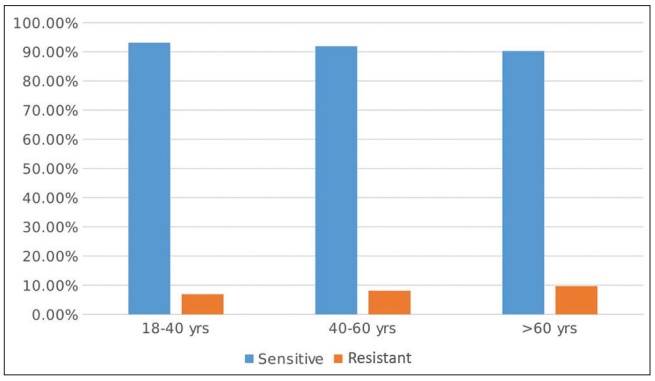

Figure 7: Oral antibiotic sensitivity based on age distribution

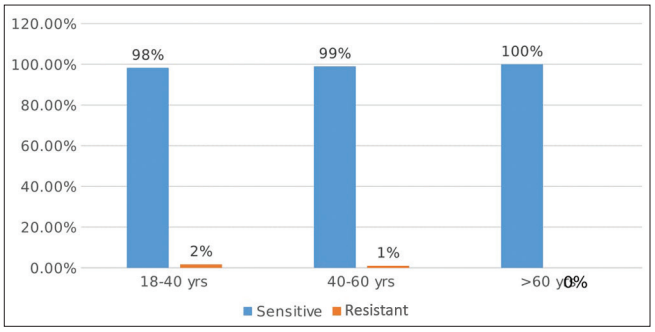

Figure 8: Parenteral antibiotic sensitivity based on age distribution

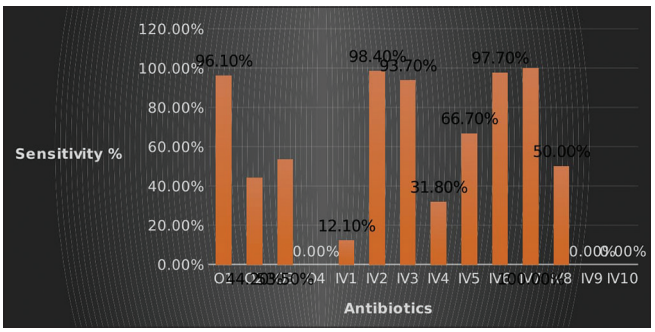

Figure 9: *Escherichia coli* sensitivity pattern to commonly used antibiotics. O1 - Nitrofurantion, O2 - Cotrimoxazole, O3 - Norfloxacin, O4 - Ciprofloxacin, IV1 - Ampicillin, IV2 - Amikacin, IV3 - Cefoperazone-sulbactam, IV4 - Cefotaxime, IV5 - Imipenem, IV6 - Piperacillin-tazobactam, IV7 - Polymyxin B, IV8 - Tobramycin, IV9 - Linezolid, IV10 - Vancomycin

and polymyxin was tested only in 2 patients, and it was sensitive in both these patients (Table 7 and Figure 10).

DISCUSSION

UTI is one of the most common bacterial infection in people visiting hospitals. UTI is far more common in females than in males, excluding infants and the elderly. In our study, male preponderance was seen (50.7%), which could be explained by the age group we included in this study (varies from 18 to 98 years), since after 50 years of

Table 5: Comparison of sensitivity pattern of antibiotics between *K. pneumoniae* and other organisms

Antibiotics	*K. pneumoniae* positive	*K. pneumoniae* negative	Total	*P* value
Nitrofurantoin				
Resistant	10	27	37	0.007
Sensitive	18	154	172	
Cotrimoxazole				
Resistant	13	86	99	0.136
Sensitive	18	66	84	
Norfloxacin				
Resistant	12	70	82	0.509
Sensitive	19	85	104	
Ciprofloxacin				
Resistant	0	8	8	-
Sensitive	0	24	24	
Ampicillin				
Resistant	31	158	189	0.017
Sensitive	0	30	30	
Amikacin				
Resistant	2	7	9	0.659
Sensitive	29	146	175	
Cefoperazone-sulbactam				
Resistant	5	12	17	0.150
Sensitive	26	140	166	
Cefotaxime				
Resistant	18	125	143	0.415
Sensitive	12	60	72	
Imipenem				
Resistant	0	3	3	0.206
Sensitive	2	3	5	
Piperacillin-tazobactam				
Resistant	3	6	9	0.166
Sensitive	28	150	178	
Polymyxin				
Resistant	0	0	0	-
Sensitive	2	5	7	
Tobramycin				
Resistant	2	4	6	0.154
Sensitive	0	5	5	
Linezolid				
Resistant	0	0	0	-
Sensitive	0	12	12	
Vancomycin				
Resistant	0	1	1	-
Sensitive	0	11	11	

K. pneumoniae: Klebsiella pneumoniae

Table 6: *E. coli* sensitivity pattern to commonly used antibiotics

S. No	Antibiotics	*E. coli* sensitive in	*E. coli* resistant in	Tested totally in	% sensitivity of *E. coli*
O1	Nitrofurantoin	124	5	129	96.1
O2	Cotrimoxazole	57	72	129	44.2
O3	Norfloxacin	68	59	127	53.5
O4	Ciprofloxacin	0	1	1	0
IV1	Ampicillin	14	116	130	12.1
IV2	Amikacin	127	2	129	98.4
IV3	Cefoperazone-sulbactam	120	8	128	93.7
IV4	Cefotaxime	41	88	129	31.8
IV5	Imipenem	2	1	3	66.7
IV6	Piperacillin-tazobactam	126	3	129	97.7
IV7	Polymyxin	2	0	2	100
IV8	Tobramycin	2	2	4	50
IV9	Linezolid	0	0	0	0
IV10	Vancomycin	0	0	0	0

E. coli: Escherichia coli

Table 7: *K. pneumoniae* sensitivity pattern to commonly used antibiotics

S. No	Antibiotics	*K. pneumonia* sensitive in	*K. pneumoniae* resistant in	Tested totally in	% sensitivity of *K. pneumoniae*
O1	Nitrofurantoin	18	10	28	64.3
O2	Cotrimoxazole	18	13	31	58.1
O3	Norfloxacin	19	12	31	61.3
O4	Ciprofloxacin	0	0	0	0
IV1	Ampicillin	0	31	31	0
IV2	Amikacin	29	2	31	93.5
IV3	Cefoperazone-sulbactam	26	5	31	83.9
IV4	Cefotaxime	12	18	30	40
IV5	Imipenem	2	0	2	100
IV6	Piperacillin-tazobactam	28	3	31	90.3
IV7	Polymyxin	2	0	2	100
IV8	Tobramycin	0	2	2	0
IV9	Linezolid	0	0	0	0
IV10	Vancomycin	0	0	0	0

K. pneumoniae: Klebsiella pneumoniae

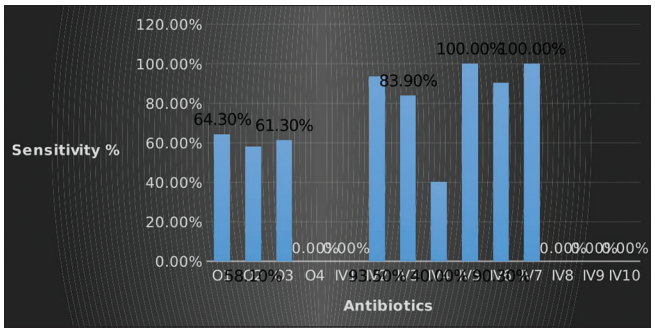

Figure 10: *Klebsiella pneumoniae* sensitivity pattern to commonly used antibiotics. O1 - Nitrofurantion, O2 - Cotrimoxazole, O3 - Norfloxacin, O4 - Ciprofloxacin, IV1 - Ampicillin, IV2 - Amikacin, IV3 - Cefoperazone-sulbactam, IV4 - Cefotaxime, IV5 - Imipenem, IV6 - Piperacillin-tazobactam, IV7 - Polymyxin B, IV8 - Tobramycin, IV9 - Linezolid, IV10 - Vancomycin

age, obstruction due to prostatic hypertrophy becomes common in men, and the incidence of UTI increases among men as well.

The most common organisms causing UTI in our study were *E. coli* (59.4%), followed by *K. pneumonia*e (14.2%), *E. faecalis* (11.4%), *Acinetobacter* species (5%), and *Staphylococcus* species (3.7%). The data is comparable to other studies where the common causative organisms in uncomplicated UTI are *E. coli* (34.4-67.0%), followed by *Enterococcus*, *Pseudomonas*, *Enterobacter*, *Klebsiella*, and *Staphylococcus*.[2-6]

In a study conducted in West Bengal, India, regarding patterns of antibiotic susceptibility of bacteria causing UTI, *E. coli* was the most common uropathogen (67.1%), followed by *Klebsiella* species (22%) and Pseudomonas species (6%). Penicillin was least effective against *E. coli* and maximum susceptibility was recorded for the drugs belonging to fourth-generation cephalosporin. *Klebsiella* species were maximally resistant to broad-spectrum penicillin, followed by aminoglycosides and third generation cephalosporins.[7] Fourth generation cephalosporin and macrolide were the most susceptible antibiotic in their study,[7] whereas, our study showed nitrofurantoin, amikacin, piperacillin-tazobactam and cefoperazone-sulbactam as the most common sensitive antibiotics.

Another study conducted in Delhi, showed that the common organisms causing community-acquired UTI were *E. coli* (68%), *Klebsiella* (16.9%) and *Proteus* (5.5%). Meropenam was the most sensitive antibiotic (100%) followed by piperacillin-tazobactam (90.2%), amikacin (75.6%) and nitrofurantoin (65.7%).[8]

In a study conducted in Karnataka,[9] a total of 181 diabetics (83 males and 98 females) and 124 non-diabetic subjects (52 males and 72 females) with UTI and significant colony count were studied. Asymptomatic bacteriuria was one of the common presentation (30%) of both diabetic and non-diabetic patients, and the prevalence of pyelonephritis in diabetic patients was significantly higher ($P = 0.04$) when compared to non-diabetic patients.

In conclusion, when patients present with symptoms of UTI, laboratory tests are necessary to make a diagnosis, identify the organisms and to provide appropriate antibiotic treatment. But empirical antibiotic has to be administered while awaiting culture reports. The appropriate antibiotic can be added by the clinician only when the data regarding the uropathogen and their antibiotic susceptibility in that locality is available for them. This study concludes that *E. coli* (59.4%) and *K. pneumoniae* (14.2%) were the common organisms and both were most sensitive to nitrofurantoin among oral antibiotics and amikacin among parenteral antibiotics.

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How to cite this article: Bhargavi MV, Senthil N, Sharmada S, Lakshmi JN, Vaasanthi R, Vengadakrishnan K, Singh RBS, Devi A. A Study on Urinary Tract Infection Pathogen Profile and Their *In Vitro* Susceptibility to Antimicrobial Agents. Int J Sci Stud 2017;4(11):136-143.

Source of Support: Nil, **Conflict of Interest:** None declared.