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A STUDY ON ANTIBIOTIC REGIMENS BASED ON CULTURE SENSITIVITY PATTERNS IN URINARY TRACT INFECTION

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ABSTRACT

Objective: The study aimed to prospectively study the antibiotic regimen used in the urinary tract infection (UTI) post culture sensitivity test and the efficiency of antibiotics. Methods: A total of 113 subjects were enrolled of age above 18 years. The patients with complaints of burning micturition, pyuria, and dysuria were recruited for the study. The suspected patient's midstream urine samples were collected and analyzed using microbial methods and underwent a culture sensitivity test. Based on the culture report of each patient antibiotic susceptibility pattern was checked. Additionally, various other kidney and blood parameters were noted. Results: We observed that in geriatric patients' values of Erythrocyte sedimentation rate (ESR), pus cells and clarity of urine were increased due to reduced immune response and co-morbidity. Most of the isolated uro-pathogens like *Escherichia coli* (47.8%), *Klebsiella pneumonia* (21.2%), and *Pseudomonas aeruginosa* (6.2%) showed sensitivity to the carbapenem class of drug-like meropenem, faropenem and resistance towards co-trimoxazole and fluoroquinolone class of antibiotic. A statistically significant difference was observed between the culture organisms and the antibiotics prescribed. Conclusions: The study provided evidence that it is necessary to conduct culture and antibiotic susceptibility tests to start an antibiotic regimen in patients with urinary tract infections. Improper choice of antibiotics may lead to resistance to uro-pathogens, which may even lead to economic burden and decrease the quality of life.

Keywords: Urinary tract infection, uropathogenic, treatment regimen, culture sensitivity pattern, Resistance

INTRODUCTION

Urinary tract infection (UTI) is the inflammatory disorder of the urinary tract caused by the abnormal growth of pathogens.[1] Various reason account for infection apart from pathogens, including risk factors such as age, sex, co-morbid disease state, multiple sex partners, catheters, pregnancy etc. Bacterial infections in the bladder, usually the lower urinary tract, are prevalent, especially among young and sexually active women in this period. The distribution of antimicrobial susceptibility data of UTI- causing microorganisms changes from time to time and from place to place. *Escherichia coli*, *Staphylococcus, Proteus, Pseudomonas, Enterococcus, and Enterobacter,* are the most prevalent pathogenic organisms isolated in UTIs.[2]

Early detection and identification of patients at risk is essential to provide better care and aids in choosing an appropriate regimen for effective treatment and preventing multidrug resistance (MDR). Increasing microbial resistance and recommending empirical therapy without taking local resistance data into account can lead to inferior treatment results. [3]

An inappropriate treatment regimen may lead to resistance in the microorganism to the antibiotic, which represents a challenge in treating infectious diseases. Hence, appropriate antibiotic therapy choices should be made only after knowing the culture and sensitivity pattern. This study is important for clinicians to facilitate empiric treatment of patients and cost-effectively manage symptoms of UTI. This study aimed to analyze and evaluate the bacteriological profile and antibiotic sensitivity pattern of UTI patients.

MATERIALS AND METHODS

A prospective observational study was designed to assess 113 patients with urological complaints. Patients admitted under the Urology and Nephrology departments of Sagar Hospitals, Jayanagar, Bengaluru were studied for six months. The research was carried out following the International Conference on Harmonization-Good Clinical Practice principles. Ethical committee clearance was obtained from the board on 02 July 2021 for the protocol to conduct a study in the hospital, study procedure, and the patient's the informed consent form.

Patients above 18 years with urological complaints of fever, pyuria, abdominal/ flank pain, dysuria, and nausea/ vomiting were recruited for the study. The patients under the Obstetrics and Gynecology department of Sagar Hospitals were excluded. Patients below 18 years of age were excluded from the study as these groups have different physiological behavior and treatment options. While conducting this prospective study, the patients were explained the antibiotic choosing pattern and possible ADRs and resistance that may occur due to improper adherence to the antibiotic. Their consent was obtained after an explanation. The recruited patient's mid-stream urine sample of 10 ml was collected and sent to the microbiological laboratory. A culture pattern was observed to find the responsible organism, and Aspirate fluid was used to test the antimicrobial sensitivity of the specific organism.

Organisms like *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas* aeruginosa, *Citrobacter koseri*, *Klebsiella pneumonia*, *Enterococcus faecalis*, *Morganella morganii* and

Serratia marcescens strains were tested against antimicrobial agents like Amikacin, Ampicillin, Amoxycillin- clavulanic acid, Cefoperazone- sulbactam, Cefotaxime, Ceftriaxone, Cefuroxime, Ciprofloxacin, Co-trimoxazole, Gentamicin, piperacillin-tazobactam, imipenem, meropenem, faropenem, tigecycline, nitrofurantoin, Cefixime.

Data management and statistical analysis were performed using SPSS software version 21.0. the variables were analyzed using the Chi-square test.

RESULTS AND DISCUSSION

A total of 113 patients with UTIs were evaluated. The common age group with UTI were those aged> 60, 52.2%, of which 24.8% were females, and 27.4% were males who were high, followed by those aged 51-60 of 25.7%, followed by 21-20 of 10.6%, and least were of age 31- 40, i.e., 1.8% from the suspected [Figure 1]. The age-wise distribution of the given population implies that the higher incidence of UTI and its complication were found in the age above 61 years; due to immunocompetence and menopausal hormonal changes in females. Thereby treatment necessities are required in elderly people to prevent complications, and based on the gender distribution, and we found that males are more affected in the age >61 years than females giving 27.4% and 24.8%, respectively. Similar findings were found in the study conducted by Prakasam K C A *et al.* (2012); males were more prone to UTI with an age group of 51-60 (58.28%) and least during 21-30 (10%). Among female patients, a higher prevalence was found in the age group 51-60 (26.5%). [4]

78.8% were with new UTI cases, and 21.2% were with recurrent complaints. Of this, 15.0% of females had recurrent UTI, and 6.2% were males with recurrent UTI [Figure 2]. Recurrency rates in the given population were 78.8% new UTI cases and 21.2% recurrent cases in 113 patients. Recurrent females were predominant over males due to the anatomical structure of the urethra, making them more vulnerable to infections and improper flushing out of the uro-pathogen, which may reactivate during patients decreased immune condition. Similarly, Pead L. *et al.* (1981) found that only 14 (6%) of 223 patients had recurrent infections than that a new infection. [5]

The most affected organisms in UTI patients were 47.8% with *Escherichia coli*, 21.2% with *Klebsiella pneumonia*, 6.2% with *Pseudomonas aeruginosa*, and 5.3% with *Staphylococcus aureus*, 3.5% with *Citrobacter koseri* and 2.7% with *Enterococcus faecalis*. Even *Escherichia coli* affected predominantly in females than males giving 27.4% and 20.4%, respectively. [Figure 3]. In percentage distribution of culture microorganisms found in the recruited patient, a greater number of infected microorganisms in the study population with *Escherichia coli* organism, as they are widespread in the everyday environment and can quickly attack the immunocompetent. Manshahia PS *et al.* (2020) showed that *Escherichia coli* was the primary causative organism and had 65% of the total isolated urine culture, and *Klebsiella pneumonia* contributed 17%. In *Escherichia coli* isolates, 68% isolates were seen in Females, and 61% isolates were found in males.[6] Bano *et al*. (2012) study showed that *Escherichia coli* was the most common isolate with 46.98%, *Klebsiella pneumonia* with 18.07% and 12.04% with *Staphylococcus aureus* and 3.61% with *Pseudomonas aeruginosa*.[7]

Of 113 patients, 10 had Culture negative and 103 tested culture positive. Culture sensitivity patterns based on gender distribution showed that the male population showed more sensitivity to faropenem (1.1%) and resistance to co-trimoxazole (1.3%), and the female population showed more sensitivity towards faropenem (1.2%) and resistance towards ciprofloxacin and co-trimoxazole (1.3%) In the Gender- wise distribution of antibiotic sensitivity and resistance pattern in the given population, this type of sensitivity study table over a particular period aid in choosing the appropriate and best antibiotics based on the population before obtaining the culture report. In the study conducted by Hossain A *et al.* (2020), the results show that bacteria from males are 2.27 times more resistant to amikacin than isolates obtained from females (CI -2.27, CI -1.22–4.11). Besides, isolates obtained from males were 2.09 times more resistant to colistin (CI - 2.09, CI -1.13–3.76) and 1.45 times more resistant to nitrofurantoin (OR -1.45, CI 1.07–1.95), compared to isolates obtained from females. Both meropenem and imipenem were found similarly effective against isolates obtained from males and females. [8]

All the predominant isolates were tested against a panel of antimicrobial agents, and a sensitivity pattern was determined. A statistical significance was obtained with *p-value <0.05. *Escherichia coli* showed more sensitivity towards meropenem, secondly toward nitrofurantoin and so on. *Klebsiella pneumonia* showed more sensitivity towards ampicillin, meropenem, piperacillin, tazobactam, and so on. *Staphylococcus aureus* showed sensitivity towards Faropenem and then towards imipenem and tigecycline. *Pseudomonas aeruginosa* showed more sensitivity towards Amoxycillin- clavulanic acid, imipenem and meropenem. Even resistance pattern was determined and found that *Escherichia coli* was more resistant towards co-trimoxazole and, secondly, towards ampicillin. *Klebsiella pneumonia* was more resistant to ciprofloxacin and co-trimoxazole, and so on. *Staphylococcus aureus* was resistant to ampicillin, gentamicin and so on. *Pseudomonas aeruginosa* was resistant towards ciprofloxacin, co-trimoxazole, piperacillin and tazobactam and so on [Table 2]. The distribution of Antibiotic sensitivity and resistance patterns about Culture microorganisms in the given population showed a significant difference between each antibiotic sensitivity and resistance pattern to the specific organism. This table study provides knowledge on the appropriate choice of antibiotic based on culture sensitivity, helps to treat the patient more efficiently with decreased cost and thereby even prevents the resistance of the organism to the newer antibiotic in the market. Similar findings were found in the study conducted by Manshahia PS *et al.* (2020) showed the sensitivity of *Escherichia coli* towards Nitrofurantoin was 92.8%. [6] Prakasam K C A *et al.* (2012), in their study, found that out of 26 *Escherichia coli* isolates, 24(92.3%) were sensitive towards meropenem, 15(42.3%) to amikacin and showed 61.5% resistance to ciprofloxacin and 26.9% to co-trimoxazole. The sensitive antibiotic to *Klebsiella pneumonia* isolates was Meropenem (100%), piperacillin-tazobactam (66.6%) and 100% resistance to norfloxacin and amikacin, 33.3% to co-trimoxazole. *Staphylococcus aureus* showed resistance to gentamicin. [4]

CONCLUSION

This study helps understand the changing antibiotics pattern according to the region and years. Penicillin was the most prescribed drug for urinary tract infections, and Escherichia coli was the most causal organism. The most prescribed antibiotic was penicillin, but the organism's sensitivity varied widely. Meropenem was the most effective treatment for Escherichia coli. Ampicillin and meropenem was the most effective treatment for Klebsiella pneumonia.

Table 1: Gender-wise distribution of antibiotic sensitivity pattern

Antibiotic Class	Antibiotic	Gender				Total
		Male		Female		
		Sensitivity	Resistance	Sensitivity	Resistance	
Aminoglycoside	AMI	20(0.6%)	27(0.8%)	27(0.8%)	29(0.9%)	103(3.2%)
	GEN	14(0.4%)	33(1%)	21(0.7%)	35(1.1%)	103(3.2%)
Penicillin derivatives	AMP	11(0.3%)	36(1.1%)	17(0.5%)	39(1.2%)	103(3.2%)
	AMC	15(0.5%)	32(1%)	22(0.7%)	34(1.1%)	103(3.2%)
	TZP	23(0.7%)	24(0.8%)	32(1%)	24(0.8%)	103(3.2%)
Cephalosporins	CPR	16(0.5%)	31(1%)	24(0.8%)	32(1%)	103(3.2%)
	CTX	22(0.7%)	25(0.8%)	29(0.9%)	27(0.8%)	103(3.2%)
	CTR	21(0.7%)	26(0.8%)	23(0.7%)	33(1%)	103(3.2%)
	CXM	19(0.6%)	28(0.9%)	25(0.8%)	31(1%)	103(3.2%)
	CFM	24(0.8%)	23(0.7%)	27(0.8%)	29(0.9%)	103(3.2%)
Carbapenem	IPM	23(0.7%)	24(0.8%)	29(0.9%)	27(0.8%)	103(3.2%)
	MEM	31(1%)	16(0.5%)	33(1%)	23(0.7%)	103(3.2%)
	FAR	34(1.1%)	13(0.4%)	39(1.2%)	17(0.5%)	103(3.2%)
Fluoroquinolones	CIP	23(0.7%)	24(0.8%)	16(0.5%)	40(1.3%)	103(3.2%)
Sulphonamides	COT	7(0.2%)	40(1.3%)	16(0.5%)	40(1.3%)	103(3.2%)
Glycylcycline	TGC	21(0.7%)	26(0.8%)	22(0.7%)	34(1.1%)	103(3.2%)
Nitrofuran	NIT	22(0.7%)	25(0.8%)	26(0.8%)	30(0.9%)	103(3.2%)

Amikacin-AMI; Ampicillin- AMP; Amoxycillin+ Clavulanic acid- AMC; Cefoperazone+ Sulbactum- CPR; Cefotaxime- CTX; Ceftriaxone- CTR; Cefuroxime- CXM; Ciprofloxacin- CIP; Co-Trimoxazole- COT; Gentamicin- GEN; Pipercillin+ Tazobactum- TZP; Imipenem- IPM; Meropenem- MEM; Tigecycline- TGC; Feropenem- FAR, Nitrofurantoin- NIT, Cefixime- CFM.

{Legends: The registered subjects were given a culture sensitivity test before receiving antibiotics. A frequency distribution cross table was created to highlight their gender-specific sensitivity and resistance patterns.}

Table 2: Distribution of antibiotic sensitivity and resistance pattern concerning culture microorganisms

Antibiotics		*E. coli*	*S. aureus*	*P. aeruginosa*	*C. koseri*	*K. pneumonia*	*E. faecalis*	*M. morganii*	*S. marcescens*
AMI	S n (%)	25(53.19)	1(2.13)	3(6.38)	2(4.26)	13(27.66)	1(2.13)	0(0)	2(4.26)
	R n (%)	29(51.79)	5(8.93)	4(7.14)	2(3.57)	11(19.64)	2(3.57)	1(1.79)	2(3.57)
AMP	S n (%)	15(53.57)	1(3.57)	3(10.71)	0(0)	8(28.57)	1(3.57)	0(0)	0(0)
	R n (%)	39(52)	5(6.67)	4(5.33)	4(5.33)	16(21.33)	2(2.67)	1(1.33)	4(5.33)
AMC	S n (%)	18(48.65)	3(8.11)	4(10.81)	0(0)	9(24.32)	2(5.41)	0(0)	1(2.7)
	R n (%)	36(54.55)	3(4.55)	3(4.55)	4(6.06)	15(22.73)	1(1.52)	1(1.52)	3(4.55)
CPR	S n (%)	22(55)	2(5)	3(7.5)	2(5)	7(17.5)	1(2.5)	1(2.5)	2(5)
	R n (%)	32(50.79)	4(6.35)	4(6.35)	2(3.17)	17(26.98)	2(3.17)	0(0)	2(3.17)
CTX	S n (%)	29(56.86)	2(3.92)	3(5.88)	2(3.92)	11(21.57)	2(3.92)	1(1.96)	1(1.96)
	R n (%)	25(48.08)	4(7.69)	4(7.69)	2(3.85)	13(25)	1(1.92)	0(0)	3(5.77)
CTR	S n (%)	25(56.82)	4(9.09)	3(6.82)	3(6.82)	6(13.64)	1(2.27)	1(2.27)	1(2.27)
	R n (%)	29(49.15)	2(3.39)	4(6.78)	1(1.69)	18(30.51)	2(3.39)	0(0)	3(5.08)
CXM	S n (%)	25(56.82)	3(6.82)	2(4.55)	1(2.27)	10(22.73)	1(2.27)	1(2.27)	1(2.27)
	R n (%)	29(49.15)	3(5.08)	5(8.47)	3(5.08)	14(23.73)	2(3.39)	0(0)	3(5.08)
CIP	S n (%)	19(48.72)	5(12.82)	2(5.13)	2(5.13)	8(20.51)	1(2.56)	0(0)	2(5.13)
	R n (%)	35(54.69)	1(1.56)	5(7.81)	2(3.13)	16(25)	2(3.13)	1(1.56)	2(3.13)
COT	S n (%)	10(43.48)	2(8.7)	2(8.7)	1(4.35)	7(30.43)	1(4.35)	0(0)	0(0)
	R n (%)	44(55)	4(5)	5(6.25)	3(3.75)	17(21.25)	2(2.5)	1(1.25)	4(5)
GEN	S n (%)	20(57.14)	1(2.86)	3(8.57)	1(2.86)	9(25.71)	1(2.86)	0(0)	0(0)
	R n (%)	34(50)	5(7.35)	4(5.88)	3(4.41)	15(22.06)	2(2.94)	1(1.47)	4(5.88)
TZP	S n (%)	31(56.36)	3(5.45)	2(3.64)	2(3.64)	12(21.82)	2(3.64)	1(1.82)	2(3.64)
	R n (%)	23(47.92)	3(6.25)	5(10.42)	2(4.17)	12(25)	1(2.08)	0(0)	2(4.17)
IPM	S n (%)	29(55.77)	5(9.62)	4(7.69)	3(5.77)	8(15.38)	1(1.92)	1(1.92)	1(1.92)
	R n (%)	25(49.02)	1(1.96)	3(5.88)	1(1.96)	16(31.37)	2(3.92)	0(0)	3(5.88)
MEM	S n (%)	34(53.13)	6(9.38)	4(6.25)	3(4.69)	15(23.44)	0(0)	1(1.56)	1(1.56)
	R n (%)	20(51.28)	0(0)	3(7.69)	1(2.56)	9(23.08)	3(7.69)	0(0)	3(7.69)
TGC	S n (%)	20(46.51)	5(11.63)	2(4.65)	3(6.98)	11(25.58)	0(0)	1(2.33)	1(2.33)
	R n (%)	34(56.67)	1(1.67)	5(8.33)	1(1.67)	13(21.67)	3(5)	0(0)	3(5)
FAR	S n (%)	0(0)	41(57.75)	4(5.63)	3(4.23)	3(4.23)	17(23.94)	2(2.82)	1(1.41)
	R n (%)	13(43.33)	2(6.67)	4(13.33)	1(3.33)	7(23.33)	1(3.33)	0(0)	2(6.67)
NIT	S n (%)	32(66.67)	1(2.08)	2(4.17)	1(2.08)	9(18.75)	1(2.08)	1(2.08)	1(2.08)
	R n (%)	22(40)	5(9.09)	5(9.09)	3(5.45)	15(27.27)	2(3.64)	0(0)	3(5.45)
CFM	S n (%)	28(54.9)	4(7.84)	2(3.92)	2(3.92)	10(19.61)	2(3.92)	1(1.96)	2(3.92)
	R n (%)	26(50)	2(3.85)	5(9.62)	2(3.85)	14(26.92)	1(1.92)	0(0)	2(3.85)

NOTE: p-value for all the antibiotics with specific organisms was obtained as p-value= 0.000, showing a greater significance level. ' S' represents sensitivity, and 'R' represents resistance.

E. coli- Escherichia coli, S. aureus- Staphylococcus aureus, P. aeruginosa- Pseudomonas aeruginosa, C. koseri- Citrobacter koseri, K. pneumonia- Klebsiella pneumonia, E. faecalis- Enterococcus faecalis, M. morganii- Morganella morganii, S. marcescens- Serratia marcescens

Amikacin-AMI; Ampicillin- AMP; Amoxycillin+ Clavulanic acid- AMC; Cefoperazone+ Sulbactum- CPR; Cefotaxime- CTX; Ceftriaxone- CTR; Cefuroxime- CXM; Ciprofloxacin- CIP; Co-Trimoxazole- COT; Gentamicin- GEN; Pipercillin+ Tazobactum- TZP; Imipenem- IPM; Meropenem- MEM; Tigecycline- TGC; Feropenem- FAR, Nitrofurantoin- NIT, Cefixime- CFM.

{Legends: The sensitivity and resistance pattern of various antibiotics used in hospitals and their frequency and percentage were acquired to choose the most appropriate treatment for the specific organism. To understand the relevance of the treatment for a specific organism, a cross-tabulation was done and tested for the significance level. We found that the p-value was <0.05 level of significance.}

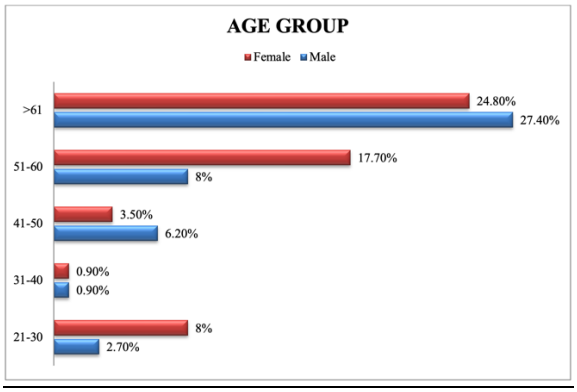

Figure 1: Age-wise distribution of the UTI cases
Legends: the total recruited population (n=113) was divided into the different age class intervals with separation of males and females, of which a more significant number of patients were identified at the age group >61 years (52.2%), and the least was found in the age group 31-40 years (1.8%). The highest prevalence was in females in the age group > 61.

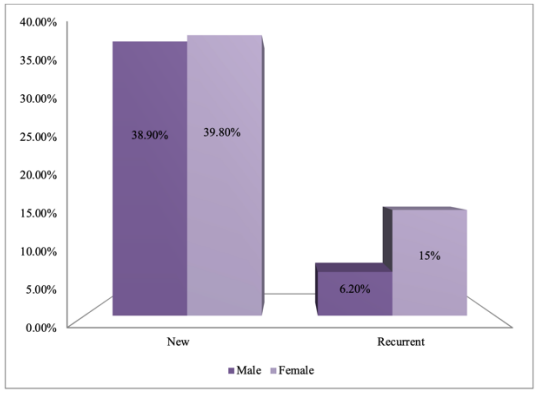

Figure 2: Distribution of subjects according to occurrence of infection
Legends: All 113 patients were noted for their recurrency, and new complaints and a bar graph were drawn showing that new cases were more than the recurrent. Of which the females with both recurrent and new cases were more than males

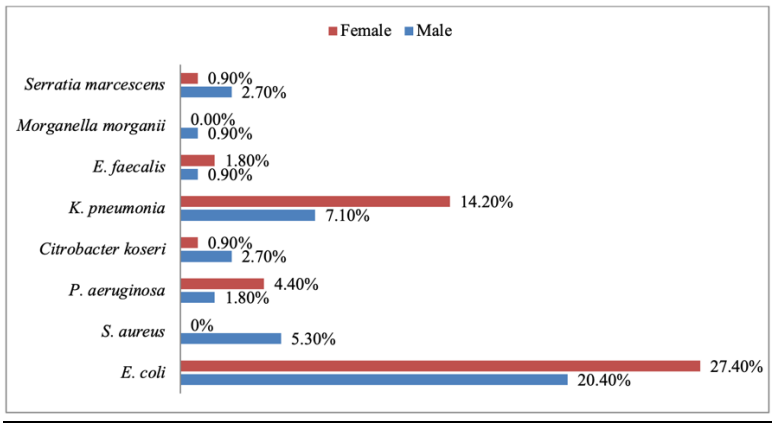

Figure 3: Percentage distribution of culture microorganisms found in recruited patient
Legends: patients' urine culture report data was collected and recorded, and all the organisms found were divided, and their percentage was drawn using a bar graph. This graph shows that *E. coli* is the most affected organism in the patients.

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