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Research Article

Prevalence and Antibiotic Susceptibility Patterns of Urinary Tract Infections in Patients Referred to a Clinical Laboratory in Isfahan, Iran, 2014 - 2015

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Abstract

Objectives: The aim of this study was to determine the prevalence of bacterial urinary tract infections (UTIs) and their antibiotic resistance patterns among patients referred to a clinical laboratory in Isfahan, Iran, during 2014 - 2015.
Methods: In this retrospective study, the data of urine culture tests which were performed from May 2014 to March 2015 at the Dr. Sharifi Clinical Laboratory were recorded and analyzed. A total of 4,506 patients with urine culture testing were included. Antimicrobial susceptibility testing was performed by the disk diffusion method according to the CLSI criteria. The gathered data were then analyzed with SPSS software using descriptive tests.
Results: Among the 4,506 studied patients with urine cultures, 300 (6.65%) and 4,206 (93.35%) urine samples showed positive and negative bacterial growth, respectively. The rates of urine cultures with bacterial growth for women and men were 90.66% and 9.44%, respectively. With regard to the bacterial growth, 90.33% were Gram-negative and 9.67% were Gram-positive. The most common isolated agent was *Escherichia coli*, followed by *Klebsiella* spp. The highest rate of resistance was seen for penicillin and ampicillin in all isolates, and the lowest resistance rate was observed for ciprofloxacin and gentamycin.
Conclusions: The results of the present study showed that antimicrobial resistance among the causative agents of UTIs is high in Isfahan, and treatment of UTIs based on antibiotic-susceptibility test results can be suggested.

Keywords: Urinary Tract Infection, Drug Resistance, Iran

1. Background

Urinary tract infections (UTIs) are amongst the most widespread types of bacterial infections throughout the world (1). They are associated with a high rate of morbidity and economic costs associated with treatment (2). UTIs may involve the kidneys, ureters, bladder, and urethra (3). They may be symptomatic or asymptomatic, which, if left untreated, can lead to serious consequences (4). It is estimated that 150 million people suffer from UTIs annually (3, 5). Although different microorganisms (*Candida albicans*, *Trichomonas vaginalis*, and a variety of bacteria) can cause UTIs, bacteria are suspected as the major cause (6).

Some studies suggest that the most common cause of uncomplicated community-acquired uropathogenesis is *Escherichia coli* (> 80%) (3). Other pathogens that cause UTIs include *Staphylococcus saprophyticus*, *Klebsiella* spp., *Proteus mirabilis*, and *Enterococcus faecalis* (7). Rapid and accurate diagnosis of UTI can be helpful in shortening the disease duration and for the prevention of complications, such as renal failure (8). Early diagnosis of acute uncomplicated cystitis is based on the patient's medical history, family and individual health information, sexual activity, and recent symptoms. Although the medical history and urine analysis are sufficient for a diagnosis of uncomplicated UTI, the gold standard is urine bacterial culture with antibiotic-susceptibility testing (1).

Treatment of UTI is based on the usage of broad-spectrum antibiotics. Excessive use of antimicrobial agents has led to growing antibiotic resistance in recent years, which has become a worldwide health problem (9, 10). The emergence of drug-resistant bacterial strains, as well as the high frequency of UTIs, has resulted in the need for a better understanding of these infections and the development of new treatment strategies (1).

2. Objectives

The aim of this study was to determine the causative agents of UTI and antibiotic sensitivity of the isolates in patients referred to the Dr. Sharifi clinical laboratory of Isfahan, Iran.

3. Methods

3.1. Study Population

The retrospective study was conducted on the recorded data from urine cultures of patients referred to the Dr. Sharifi clinical laboratory, Isfahan, Iran, from May 2014 to March 2015. A total of 4,506 urine culture tests from patients suspected to have UTIs were recorded and studied. Samples from adult patients were collected from midstream urine, while samples from children aged < 3 years were obtained using sterile urine bags.

3.2. Urine Cultures

Urine samples were cultured within an hour of sampling. All samples were processed on blood agar and MacConkey agar media, and incubated overnight at 37°C. In negative cases, the samples were incubated for an additional 24 hours. Identification of Gram-negative bacteria was based on standard biochemical tests. Gram-positive bacteria were identified with laboratory tests, including catalase, coagulase, CAMP, and esculin agar. Culturing and identification of the isolates was done based on Bailey and Scott diagnostic microbiological methods. The isolated bacteria were characterized and identified using Gram staining and biochemical testing. ATCC strains were used for quality assurance (11).

3.3. Antibiotic Susceptibility Tests

Antimicrobial susceptibility tests were performed with the disk diffusion method according to the criteria introduced by the CLSI. The following antibiotics (Pad Tan Teb, Iran) were tested on the positive urine cultures: gentamycin (10 μg), nitrofurantoin (300 μg), ofloxacin (5 μg), co-trimoxazole (trimethoprim sulfamethoxazole; 25 μg), penicillin (10 μg), cefpodoxime (10 μg), cefixime (5 μg), ceftriaxone (30 μg), erythromycin (15 μg), cefotaxime (30 μg), cephalothin (30 μg), nalidixic acid (30 μg), vancomycin (30 μg), and ampicillin (10 μg).

3.4. Data Analysis

Data were analyzed with SPSS software (version 16.2, SPSS Inc., Chicago, IL, USA) through the chi-square, one-way analysis of variance (ANOVA), and Kruskal-Wallis tests.

4. Results

In the present study, the results of 4,506 urine culture tests were analyzed. In total, 300 (6.65%) and 4,206 (93.35%) samples were positive and negative for bacterial growth, respectively. The rates of positive cultures for women and men were 90.66% (455 samples) and 9.44% (28 samples), respectively. Considering the bacterial growth, 90.33% of the UTIs were caused by Gram-negative bacteria, while 9.67% were Gram-positive. Analysis of the results according to gender showed that although *E. coli* was the predominant isolate in both sexes, its frequency was higher in women (90.79%) compared to men (9.21%). Infections due to *S. saprophyticus*, *P. mirabilis*, and Group D streptococci were observed only in women (Table 1).

The rates of antibiotic resistance of bacterial isolates from UTIs are shown in Table 2. *E. coli*, the most prevalent cause of UTI, showed the highest and lowest rates of resistance against ampicillin and nitrofurantoin, respectively. Furthermore, *Klebsiella* spp. were also highly resistant to ampicillin and nalidixic acid. In total, the highest antibiotic resistance was observed against ampicillin and penicillin.

5. Discussion

Several studies have been conducted on the antibiotic resistance patterns of UTIs (12-15). According to the results of the present study, the predominant bacteria isolated from urine cultures in both sexes were *E. coli*. The results of 4,506 urine culture tests were analyzed and showed 6.65% of UTI in the humans that were suspected to have UTIs. In addition, there is a higher rate of UTIs in women compared to men, which may be due to the higher number of women referred to the laboratory, as well as the anatomy of the female urogenital system. Furthermore, according to our results, *E. coli* is an important cause of UTIs, and the highest rate of antibiotic resistance was observed against ampicillin, erythromycin and penicillin, while the lowest resistance was seen for nitrofurantoin and gentamycin.

In this study, no *E. coli* isolate was observed to be sensitive to ampicillin, vancomycin, erythromycin and penicillin. In the study carried out by Linhares et al. (2013), the

Table 1. Bacterial Isolates From Urinary Tract Infections

Isolated Bacteria	Bacterial Growth N (%)	Sex		Mean Age (yrs)
		Female	Male	
S. aureus	18 (0.4)	17	1	35.06
S. saprophyticus	10 (0.22)	10	0	32.14
E. coli	163 (3.62)	148	15	38.19
***Klebsiella* spp.**	81 (1.8)	72	9	29.57
P. mirabilis	5 (0.11)	5	0	32.40
***Citrobacter* spp.**	14 (0.31)	11	3	47.08
***Enterobacter* spp.**	8 (0.17)	8	0	41.29
Group D streptococci	1 (0.02)	1	0	72
Total bacterial growth	300 (6.65)	272 (90.66)	28 (9.44)	36.62
No bacterial growth	4,206 (93.35)			
Total	4,506			
P value		0.449		0.153

resistance rates against penicillin and co-trimoxazole were reported as 3% and 25.9%, respectively (2). With regard to *E. coli*, the rate of resistance against co-trimoxazole in the report from Kalantar et al., (2008) was 85.9% (16), which is higher than that in our study. In another study on UTIs in children, the lowest resistance rate of *E. coli* was reported against ciprofloxacin (17), which is close to the findings of the present study.

Most of the antibiotic resistance of bacteria involved in UTIs is reported against ampicillin (18, 19). In the present study, the overall frequency of resistance to ampicillin (85.5%) was considerably higher than that in a previous study from Turkey by Yuksel et al. (2006) (13). For *Klebsiella* spp. and *Proteus mirabilis*, high rates of antibiotic resistance were observed for nalidixic acid and tetracycline, respectively. Similar studies in Iran showed different results regarding the antibiotic-sensitivity patterns in UTIs (20-23). Khoshbakht et al. (2012) reported a higher rate of positive cultures in women compared to men (88.69% versus 11.3%), which is similar to our findings. They also suggested *E. coli* as the major cause of UTI, showing the highest rate of resistance against cephalothin (88.16%), which is higher compared to our study (54.33%) (20). A study carried out by Piranfar et al. (2014) showed *E. coli* as the main cause of UTIs, and it was mostly resistant to co-trimoxazole (23). Based on the results of the present study, *E. coli* is the prevalent causative agent of UTI and is highly resistant against ampicillin and erythromycin.

5.1. Limitations

The present study was carried out on the recorded data of patients referred to the Dr. Sharifi Clinical Laboratory in Isfahan, Iran. Thus, the laboratory workup was outside our authority.

5.2. Conclusion

The differences in the prevalence of bacterial UTIs and in the antibiotic resistance patterns in each area demonstrate the importance of antibiotic resistance monitoring programs. Based on the results of the present study, *E. coli* is the most prevalent isolate from UTIs and also ceftriaxone, cefotaxime, and ciprofloxacin are the most effective choices for the treatment of UTIs in the Isfahan area of central Iran.

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Table 2. Antibiotic Resistance Pattern Among the Studied Bacterial Isolates from Urinary Tract Infections

	S. aureus	***S. saprophyticus***	***E. coli***	***Klebsiella* spp.**	***P. mirabilis***	***Citrobacter* spp.**	***Enterobacter* spp.**	**Group D streptococci**	**Total**	**P value**
Gentamycin										0.591
S	6	5	51	18	0	4	2	ND	86 (42.36)	
I	3	0	45	28	4	7	4	ND	91 (44.82)	
R	1	2	15	5	1	1	1	ND	26 (12.8)	
Nitrofurantoin										< 001
S	9	2	57	8	0	4	4	1	58 (39.45)	
I	1	2	35	19	4	7	0	0	68 (46.25)	
R	0	0	6	14	1	1	1	0	21 (14.28)	
Ofloxacin										0.158
S	1	0	33	12	1	4	2	0	53 (48.18)	
I	1	1	12	6	1	4	0	0	25 (22.72)	
R	2	3	18	5	1	1	1	1	32 (29.09)	
Co-trimoxazole										0.041
S	5	3	29	24	0	5	2	0	68 (37.56)	
I	1	1	15	8	0	2	0	1	27 (14.91)	
R	8	3	52	14	2	3	4	0	86 (47.51)	
Tetracycline										0.165
S	0	0	3	3	0	ND	ND	ND	6 (14.63)	
I	5	0	6	2	0	ND	ND	ND	13 (31.7)	
R	2	2	9	6	3	ND	ND	ND	22 (53.65)	
Penicillin										0.021
S	3	0	0	ND	ND	ND	ND	ND	3 (20)	
I	0	0	1	ND	ND	ND	ND	ND	1 (6.66)	
R	6	3	2	ND	ND	ND	ND	ND	11 (73.33)	
Ciprofloxacin										0.613
S	5	1	54	28	ND	7	2	ND	97 (68.3)	
I	0	0	8	4	ND	3	0	ND	25 (17.6)	
R	0	1	13	5	ND	0	2	ND	20 (14.08)	
Cefixime										0.194
S	ND	ND	6	5	1	1	ND	ND	13 (54.16)	
I	ND	ND	3	1	1	0	ND	ND	5 (20.83)	
R	ND	ND	5	1	0	0	ND	ND	6 (25)	
Ceftriaxone										0.428
S	1	0	28	10	1	1	1	ND	42 (70)	
I	0	1	1	0	0	0	0	ND	2 (3.33)	
R	0	0	7	7	0	0	2	ND	16 (26.66)	
Erythromycin										0.206
S	3	1	0	0	0	ND	0	0	4 (33.33)	

I	0	2	3	1	0	ND	0	0	6 (50)	
R	2	2	10	3	1	ND	1	1	2 (16.66)	
Cefotaxime										0.917
S	ND	ND	38	22	2	7	2	ND	71 (72.44)	
I	ND	ND	7	1	1	1	0	ND	10 (10.2)	
R	ND	ND	11	5	0	1	0	ND	17 (17.34)	
Cephalothin										0.022
S	1	1	1	0	1	0	1	1	6 (19.35)	
I	0	0	7	3	0	0	1	0	11 (35.48)	
R	0	0	12	1	0	1	0	0	14 (45.16)	
Nalidixic acid										0.139
S	1	0	25	10	2	1	1	0	40 (22.59)	
I	0	0	16	18	0	4	1	0	39 (22.03)	
R	7	2	61	16	0	7	2	1	98 (55.36)	
Vancomycin										0.349
S	1	0	0	0	ND	ND	ND	ND	1 (7.69)	
I	3	1	0	1	ND	ND	ND	ND	5 (38.46)	
R	3	2	2	0	ND	ND	ND	ND	7 (53.84)	
Ampicillin										0.002
S	3	0	0	1	0	0	0	ND	4 (6.44)	
I	0	0	3	1	1	0	0	ND	5 (8.06)	
R	0	1	24	13	0	1	4	ND	53 (85.5)	
Cefoxitin										0.380
S	ND	ND	1	1	ND	ND	ND	ND	2 (40)	
I	ND	ND	0	0	ND	ND	ND	ND	0	
R	ND	ND	3	0	ND	ND	ND	ND	3 (60)	

Abbreviations: S, sensitive; I, intermediate; R, resistant; ND, not defined.