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Bacterial Uropathogens in Urinary Tract Infection and Antibiotic Susceptibility Pattern in Riyadh Hospital, Saudi Arabia

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Abstract

Background: Urinary tract infection (UTI) is one of the commonest infections encountered by clinicians and despite the widespread availability of antimicrobial agents. UTI has become difficult to treat because of appearance of pathogens with increasing resistance to antimicrobial agents.

The aim and objectives of this study were to determine the etiological Bacterial pathogens of the UTI and to determine the antibiotic sensitivity pattern of pathogens isolated.

Results: The present study was carried out from the Central Laboratory of Riyadh Hospital in Saudi Arabia from January 2015 to Jun 2015.Total 116 urine samples were tested bacteriologically and for antibiotic susceptibility using standard procedures.

This study describes the relationships between sex, isolated bacterial agents and antibiotic resistance of UTIs. Out of 116 samples of out patients, urinary tract infection (UTI), of these 70(60.35%) belonged to female and 46(39.66%) samples belonged to male patients, while adult patients included (22.41%) of female as well as male patients with the same percentage. It was found that old adult women have a higher prevalence of UTI than men. *Escherichia coli* was the most common isolate (78.45%) followed by *Klebsiella pneumoniae* (21.56 %) amongst the gram-negative bacilli. Also, the results showed that, *E. coli* occurred more frequently in women (50%) than in men (28.45%).

All isolates of *E. coli* and *K. pneumoniae* were high susceptible to Meropenem, Imipenem, Colistin, Ertapenem and Amikacin.

Conclusions: This study showed that *E. coli* isolates were the predominant pathogens and showed increasing resistance pattern to the commonly prescribed drugs in private practice that in turn leaves the clinicians with very few alternative options of drugs for the treatment of UTIs.

Keywords: Urinary tract; Infections; Antibiotic susceptibility; Outpatients

Abbreviations

UTI: Urinary Tract Infection; *Escherichia coli: E. coli; Klebsiella pneumoniae: K. pneumoniae;* CLSI: Clinical and Laboratory Standards Institute

Introduction

Urinary tract infections (UTI) are one of the most common infectious diseases diagnosed in outpatients as well as in hospitalized patients, and can lead to significant mortality [1]. UTI account for a large proportion of antibacterial drug consumption and have large socio-economic impacts [2]. UTIs refer to the presence of microbial pathogens within the urinary tract and it is usually classified by the infection site:- bladder (cystitis), kidney (pyelonephritis), or urine (bacteriuria) and also can be asymptomatic or symptomatic, UTIs that occur in a normal genitourinary tract with no prior instrumentation are considered as “uncomplicated,” whereas “complicated” infections are diagnosed in genitourinary tracts that have structural or functional abnormalities, including instrumentation such as indwelling urethral catheters, and are frequently asymptomatic [3,4]. Urinary tract infection (UTI) is one of the most common infections affecting different age group of the patients [5]. The international studies have shown that UTIs in women are very common; therefore, one in five adult women experience UTI in her life and it is extremely common, clinically apparent, worldwide patient problem [6-9]. More than 95% of urinary tract infections are caused by a single bacterial species. E. *coli* is the most frequent infecting organism in acute infection [10,11]. *Klebsiella, Staphylococci, Enterobacter, Proteus, Pseudomonas, and Enterococci* species are more often isolated from inpatients, whereas there is a greater preponderance of *E. coli* in an outpatient population [12]. The relative frequency of the pathogens varies depending upon age, sex, catheterization, and hospitalization [13]. The

most frequent uropathogens were Gram negatives which made up 80.9% of all the isolates. *E. coli* was the most common bacteria isolated from urine samples in both outpatients and inpatients of both sexes [14].

Treatment of UTI is often started empirically and therapy is based on information determined from the antimicrobial resistance pattern of the urinary pathogens [15]. The prevalence of antimicrobial resistance among urinary pathogens has been increasing worldwide due to aberrant use of antibiotics in practice [16,17]. Distribution of urinary pathogens and their susceptibility to antibiotics varies regionally so it becomes necessary to have knowledge of distribution of these pathogens and their susceptibility to antibiotics in a particular setting [18,19]. The estimation of local etiology and susceptibility profile could support the most effective empirical treatment [20].

The aim of this study was to determine bacterial etiologic agents responsible for urinary tract infection and to evaluate their *in vitro* susceptibility pattern to commonly used antimicrobial agents. This study is important to facilitate the effective treatment and management of patient with symptoms of urinary tract infection referred to the Central Laboratory of Riyadh Hospital, Saudi Arabia on a period of (January 2015-Jun 2015).

Materials and Methods

A prospective study was planned to determine the etiological Bacterial pathogens of the UTI and to determine the antibiotic sensitivity pattern of pathogens isolated. Total 116 samples of urinary tract infection (UTI) outpatients, were collected during this study period. For collection of urine samples patients were advised to collect a clean catch midstream urine specimen in a sterile, wide mouthed leak proof container supplied by the Central Riyadh Hospital and bring to the laboratory as early as possible.

There were 70 (60.35%) urine samples from female patients and 46 (39.66%) from male patients. Adult patients were sampled by clean catch midstream urine, and children aged less than 3 years were sampled using sterile urine bags.

In this survey, cases with or without clinical symptoms of UTIs were studied retrospectively [7,21]. Data collection were conducted by a questionnaire consisting of short-answer questions including, Dates, Bacterial agents (First, Second and Third Pathogen), Diagnostic techniques, Sex and Age of patients, Predisposing factors and Mortality. In the present study, the patients who referred to the Central Riyadh Hospital were studied, on a period of (January 2015-Jun 2015).

Isolation and Identification of Bacterial Pathogens

Total 116 urine samples were collected during this study period. A measured amount of urine, using calibrated loop method was inoculated to nutrient agar medium (Merck, Germany) for colony count. Equal or more than 104 CFU/ml of a single potential pathogen or for each of two potential pathogens interpreted as positive UTI and a result of 102 CFU/ml to 104 CFU/ml was repeated. A less than 102 CFU/ml was interpreted as negative UTI [22]. Urine specimens were cultured for isolation of the microbial agents of UTI on blood agar and MacConky Agar media. The plates were then incubated at 37°C aerobically for 24 hrs. They were then examined for bacterial growth. All the bacteria isolated from urine in this study were identified using conventional biochemical tests [23-25]. More than 95% of urinary tract infections are caused by a single bacterial colony count of bacteria in UTI.

Table 1 Frequency of bacterial agents isolated from urine specimens and their relation to sex and age group in this study.

Type	Children*		Young**		Adult***	
Sex	F	M	F	M	F	M
Total count	20	12	24	8	26	26
Of patients	17.42	10.35	20.69	6.90	22.41	22.41
%						
Bacterial spp.						
Escherichia coli	16	9	18	5	24	19
%	13.79	7.76	15.52	4.31	20.69	16.38
Klebsiella pneumonia	4	3	6	3	2	7
%	3.45	2.59	5.17	2.59	1.72	6.03

Total number of out patients=116 *Children (0-14 years) ** Young (15-50 years) *** Adult (51-100 years)

Antibiotic Susceptibility Testing

In the present study antimicrobial susceptibility testing was done on Mueller- Hinton agar using disk diffusion (Kirby Bauer's) method according to the clinical and laboratory standards institute (CLSI) guidelines using the following 21 antimicrobial agents: Amikacin (30 µg), Gentamicin (10 µg), Ciprofloxacin (5 µg), Ertapenem (30 µg), Nitrofurantoin (300 µg), Imipenem (30 µg), Meropenem (30 µg), Trimethoprim/ Sulfamethoxazole (25 µg) [15], Tigecycline (30 µg), Piperacillin/ Tazobactam (30 µg), Levofloxaacin (30 µg), Colistin, Cephalothin, Cefuroxime (10 µg), Ceftriaxone (30 µg), Ceftazidime (30 µg), Cefoxitin (30 µg), Cefepime (30 µg), Aztreonam (30 µg), Ampicillin (10 µg) and Amoxicillin (30 µg) for all Bacterial isolates.

Data were entered and analyzed using SPSS version 12.0.1 windows. Discrete variables were expressed as percentages and proportions were compared using the Chi-square test. Statistical significance difference was considered at value of $p<0.05$ (IBM, Chicago, IL, USA).

Results

Total 116 samples of urinary tract infection (UTI) outpatients, were collected during this study period. Among

these 70(60.35%) belonged to female and 46(39.66%) samples belonged to male patients. Among them adult patients occurred in (22.41%) of female as well as male patients with the same percentage, and most of them were old adults **(Table 1)**. The most common isolates in this study have been the Gram-negative bacilli which accounts for 100% of the total positive isolates. In the Gram-negative bacilli, the predominant isolate was the *Escherichia coli* (78.45%) followed by *Klebsiella pneumoniae* (21.56%), which is the second most prevalent pathogen of UTI. Beside them, it was found that four types of other bacterial species have been isolated from three cases who infected with *E. coli* or *K. pneumoniae* and they were (*Pseudomonas aeruginosa* (2.58%), *Morganella morganai* (0.86%), *Proteus mirabilis* (0.86%) and a Gram-positive *Enterococcus faecalis* (0.86%), **Table 2** shows the detailed frequency of all the isolates identified. The most common pathogens isolated were *E. coli* (78.45%), from female patients (50%) and (28.45%) from male patients. The high percentage of *K. pneumoniae* (6.03%), was isolated from adult male patients **(Table 2)**.

Table 2 Distribution of positive bacterial isolates identified from urine samples and their relation to sex in this study.

Bacterial spp.	*E. coli*	*K. pneumonia*	*P. aeruginosa*	*M. morganii*	*E. faecalis*	*P. mierabilis*
Females	58 (50%)	12 (10.35 %)	2 (1.72%)	1 (0.86%)	---	---
Males	33 (28.45 %)	13 (11.21%)	1 (0.86%)	---	1 (0.86%)	1 (0.86%)
Total count	91 (78.45%)	25 (21.56 %	3 (2.58%)	1 (0.86%)	1 (0.86%)	1 (0.86%)

Bacterial Susceptibility

The comparison of the susceptibility pattern of organisms to various antimicrobial agents from all the specimens was shown in **Table 3**. *E. coli* showed high susceptibility (98.90%) to each of amikacin, meropenem, imipenem, ertapenem and colistin. But, to tigecycline (93.41%), to nitrofurantion (89.01%), to cefoxitin (86.81%) and to piperacillin/tazobactam (84.62%). Nevertheless, there was a decreased susceptibility to gentamicin (64.84%). *E. coli* exhibited resistance to the commonly used antibiotics as shown in **Table 3**.

Also, *K. pneumoniae* was highly susceptible to Meropenem (96%), Imipenem (96%), Colistin (92%), Ertapenem (88%), Amikacin and Levofloxacin (80%), but there was a low susceptibility pattern of *K. pneumoniae* to cefoxitin (76%), to Piperacillin/Tazobactam (56%) and to Ciprofloxacin (48%), to Gentamicin (28%), to Tigecycline (20%), to Nitrofurantion (16%). The organism showed high resistance to common used urinary antibiotics as in *E. coli* except Levofloxacin (**Table 3**). *E. coli* and *K. pneumoniae* showed the highest percentage of resistance to Ampicillin, Aztreonam, Cefepime, Ceftriaxone, Cefuroxime, Cephalothin, Ceftazidime and Amoxicillin (**Table 3**).

Discussion

This study describes the relationships between sex, isolated bacterial agents and antibiotic resistance of UTIs. Among 116 samples of outpatient's urinary tract infection (UTI), of these 70 (60.35%) belonged to female and 46 (39.66%) samples belonged to male patients, while adult patients included (22.41%) of female as well as male patients with the same percentage.

Table 3 Distribution of antibiotic susceptibility amongst the bacterial isolates from urine specimens.

Antibiotic susceptibility (%)	*K. pneumonia*	*E. coli*
Ciprofloxacin	28% R	62.64% R
	48% S	25.56% S
Trim/Sulfam	76% R	70.33% R
Tigecycline	20% S	93.41% S
Piperacillin/Ta	56% S	84.62% S
Nitrofurantion	16% S	89.01% S
Meropenem	96% S	98.90% S
Levofloxacin	80% S	63.23% R
Imipenem	96% S	98.90% S
Gentamicin	28% S	64.84% S
Ertapenem	88% S	98.90% S
Colistin	92% S	98.90% S
Cephalothin	88.% R	98.89% R
Cefuroxime	88% R	98.89% R
Ceftriaxone	88% R	98.89% R
Ceftazidime	84% R	98.90% R
Cefoxitin	76% S	86.81% S
Cefepime	88% R	96.70% R
Aztreonam	88% R	98.90% R
Ampicillin	88% R	98.90% R
Amoxicillin	84% R	98.90% R
Amilkacin	80% S	98.90% S

Similar study, was conducted in Rawalpindi by Inam Ullah Khan et al. revealed that the bulk of the urinary isolates were

from female patients (70%) as UTIs are frequent in females due to short urethra. The international studies have shown that UTIs in women are very common; therefore, one in five adult women experience UTI in her life and it is extremely common, clinically apparent, worldwide patient problem [7,8,9,13,26,27]. Approximately 1 in 3 women will require antimicrobial treatment for a UTI before age 24, and 40% to 50% of women will have a UTI during their lifetime [28]. The sex distribution of patients in our study is consistent with those of other reported studies, showing a statistically predominance of females with UTI [29,30].

This result is similar to those reported from many other centers [31,32]. It has been extensively reported that adult women have a higher prevalence of UTI than men, principally owing to anatomic and physical factors [33]. The elevated incidence of infection among females is related to differences between the male and female genitourinary systems in anatomy and microflora [34]. The Enterobacteriaceae family were the most common microorganism isolated of Urinary tract infection in the present study accounting 100% of total isolated bacteria. Amongst them *E. coli* (78.45%) was the most predominant bacteria, followed by *K. pneumoniae* (21.56 %), which is the second most prevalent pathogen of UTI, and this finding is in agreement with others finding too [2,20,22,35-37]. Several authors around the world have been reported that the Gram-negative bacteria of *E. coli* and *Klebsiella spp.* being the most frequent organisms causing UTIs [3,6,7,38,39]. Also, *E. coli* is the major aetiological agent in causing UTI, which accounts for up to 90 % of cases [11]. While, In the present study *E. coli* occurred more frequently in women (50%) than in men (28.45 %), also these findings consisting with the results of Ziad Daoud and Claude Afif [29].

E. coli and *K. pneumoniae* showed the highest percentage of resistance to Ampicillin, Aztreonam, Cefepime, Ceftriaxone, Cefuroxime, Cephalothin, Ceftazidime and Amoxicillin. On the other hand, very low resistance was detected to antibiotics such as Ciprofloxacin and Trimethoprim/Sulfamethoxazole for all these isolates. However, Manikandan and Amsath found that, *Klebsiella* spp. isolates showed higher resistance were Amoxiclillin (88.9%), Ampicillin (83.3%), Cotrimoxazole (70.8%) nalidixic acid (50.6%), nitrofurantoin (50.0%) and Norfloxacin (25.0%). In the present study, all UTI isolates of *E. coli* and *K. pneumoniae* were high susceptible to Meropenem, Imipenem, Colistin, Ertapenem and Amikacin. This study is comparable with the results reported by Astal et al. [40] and McIsaac et al. [41]. Based on the results of the present study, it was revealed that the susceptibility of bacteria to Ciprofloxacin and other antibiotics was similar to many studies [40,42]. But, there was a low susceptibility pattern of *K. pneumoniae* to nitrofurantion. It was found that fluoroquinolones should only be used for the treatment of acute UTIs for women who should not be prescribed nitrofurantoin, trimethoprim-sulfamethoxazole or Fosfomycin [43].

Conclusion

It is concluded that, females have a higher prevalence of UTI than males. As especially old adult women were more affected by UTI than men. Gram-negative bacilli (*Enterobacteracea*) were responsible for urinary tract infections and *E. coli* occurred more frequently in women than in men.

Most of the strains were multi-drugs resistant. The most common isolated bacteria from urinary tract Infections was *E. coli* and the most effective antimicrobial agents were Amikacin, Meropenem, Imipenem, Colistin and Ertapenem against *E. coli* and *K. pneumoniae.* In order to prevent or decrease resistance to antibiotics, the use of antibiotics should be kept under supervision, should be given in appropriate doses for an appropriate period of time [3,44].

Ethics Approval and Consent to Participate

1. A consent to collect the samples is obtained from different hospitals and centers included in the study.

2. Valid consent of the person under the study [45,46]

3. Maintaining confidentiality of information obtained from subjects under the study.

4. Complete information regarding risk factors is handed to all patients under the study and no concealment what so over.

5. Results of samples collected are donated to all patients included in the study and some sample results were dispatched to physicians for treatment prescription [47-49].

Consent for Publication

Not applicable.

Availability of Data and Materials

Please contact author for data requests.

Conflict of Interest

The author declares that she has no conflict of interest.

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