Evaluation of etiologic agents and antimicrobial resistance pattern of urinary tract infections in the northwest of Iran

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Abstract

Introduction: The present study was conducted aiming to identify the causative agents of urinary tract infection (UTI) as one of the most common bacterial infections and their antimicrobial resistance patterns.

Methods: The current cross-sectional study was carried out on urine specimens retrieved from patients with urinary infections (UIs) in the central laboratory of Tabriz University of Medical Sciences, Tabriz, Iran during 2013-2014. After culture-based identification of the isolates, the antibiogram test was conducted according to Clinical and Laboratory Standards Institute (CLSI) protocol.

Results: 3205 (5.7%) of 56564 urine specimens were positive in terms of urine culture (UC), of which, 77.3% and 22.7% belonged to women and men, respectively. Moreover, the results showed that the highest rate of bacteria responsible for UI belonged to Escherichia coli (E. coli). According to the results of the antibiogram test, the highest rates of bacterial resistance were related to ampicillin, cephalothin, and co-trimoxazole with 74.2%, 68.1%, and 54.0%, respectively. In addition, the highest rates of bacterial susceptibility belonged to amikacin, nitrofurantoin, and gentamicin with 79.0%, 77.8%, and 74.5%, respectively.

Conclusion: This study showed that most of the bacteria isolated belonged to the family of gram negative bacilli. The antibiotic resistance pattern of microorganism is responsible for UIs in different regions. Comparing the results of the present study with previous studies carried out in the northwest of Iran and around the world showed an increasing trend in UI. Therefore, proper administration of antibiotics based on the antibiogram test is necessary.

Introduction

Urinary tract infection (UTI) is still one of the most common infectious diseases all over the world, which engages 150 million individuals of different ages every year which can cause severe and complicated outcomes.[1] Various microorganisms can cause UTI, however, its most common agent is Escherichia coli (E. coli) causing almost 80% of these infections.[2-4] Due to the proximity of the urethra to the anus and its short length and due to changes in the microbial flora of the vagina at the time of menopause among women, UTI is more common among women than men.[5,6]

Most often, treatment begins empirically in order to reduce the period of the disease and its complications,; therefore, rapid and

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accurate identification of the causative agent and selection of a suitable antibiotic are significant in reducing the period of the disease and preventing the spread of infection to other sites.[3,4] However, antibiotic resistance of bacteria due to the frequent and improper use of antibiotics have unfortunately caused failure of treatment and an increase in the rates of disability and death, and imposed huge expenses in the field of health.[1] Thus, the empirical therapy of UTI relies on predicting the agents causing infection and knowledge on their antimicrobial susceptibility patterns. However, given that the epidemiology of UTIs and their antimicrobial resistance pattern varies in different regions, therefore continuous evaluation of the incidence of pathogens and antimicrobial resistance in each region is necessary. So, the present study was carried out with the aim to determine the incidence of pathogenic bacteria and antibiotic resistance patterns of the causative uropathogens in the northwest of Iran.

Methods

The present cross-sectional analytical and descriptive study was conducted on a total of 56564 non-duplicate midstream urine samples from March 2013 to February 2014. The samples were collected from outpatients with symptomatic UTI submitted to the central laboratory of Tabriz University of Medical Sciences, Tabriz, Iran, then the collected samples were investigated. The patients without a recent experience of taking any antibiotics in the previous sampling were included in the study.

All specimens were cultivated on blood agar and MacConkey agar (Merck, Germany) using calibrated sterile loop technique and incubated at 37 °C for 24 h. Cultures with bacterial counts of $\geq 10^5$ cfu/ml or cultures with bacterial counts of $\geq 10^4$ and also ≥ 5 white blood cells (WBC) per high-power microscope field of urine sediment were considered as UTIs. The isolated bacteria were identified by standard conventional biochemical tests.

Antimicrobial susceptibility testing was performed for isolates by the disc diffusion according to the Clinical and Laboratory Standards Institute (CLSI) recommendations. Antimicrobial agents used included gentamicin, nitrofurantoin, ciprofloxacin, nalidixic acid, amikacin, cephalothin, cotrimoxazole, oxacillin, penicillin, erythromycin, vancomycin, and ampicillin.

Results

In the present study, out of 56555 urine specimens suspected of urinary infection, 43719 (77.3%) and 12836 (22.7%) belonged to women and men, respectively. In addition, 3196 (5.6%) of the samples were positive regarding urine culture. Analysis of the urine specimens showed that E. coli was the most common cause of such infections with 68.9%, followed by Klebsiella spp., Enterococcus, Pseudomonas spp., Staphylococcus aureus, Streptococcus spp., Staphylococcus epidermidis, Enterobacter aeruginosa, Citrobacter spp., and Staphylococcus saprophyticus with a rate of 6.8%, 6.1%, 3.6%, 3.3%, 3.2%, 3.0%, 2.4%, 1.2%, and 1.2%, respectively.

According to the results of antibiogram test, the highest rates of antibiotical resistance were related to ampicillin, cephalothin, and co-trimoxazole with 74.2%, 68.1%, and 54.0%, respectively. In addition, the highest rates of bacterial susceptibility belonged to amikacin, nitrofurantoin, and gentamicin with 79.0%, 77.8%, and 74.5%, respectively (Table 1).

Discussion

To the best of our knowledge, this study is the most comprehensive report showing the incidence of uropathogens and their antimicrobial resistance pattern among 56564 patients suspected to UTI in the northwest Iran. In the present study, the rate of UTI was only 5.6%. This can be due to the fact that most clinical symptoms of UTI are not specific, and diagnosis of this disease is not carried out with sufficient accuracy; therefore, a definitive diagnosis depends on the outcome of urine culture. In a similar study carried out, Farajnia et al. reported the incidence rate of UTIs as 13.2%.[4]

Table 1. Resistance of isolated bacteria from positive urine samples to commonly used antibiotics

Organism	Number of isolates	Antibiotic						
		GEN [n (%)]	FM [n (%)]	CIP [n (%)]	SXT [n (%)]	AN [n (%)]	CF [n (%)]	AM [n (%)]
Escherichia coli	2203	496 (22.5)	346 (15.7)	731 (33.2)	1195 (54.2)	242 (11.0)	1536 (69.7)	1754 (79.6)
Enterococci	196	129 (65.8)	16 (8.2)	80 (40.8)	0 (0)	144 (73.5)	140 (71.4)	27 (13.8)
Klebsiella spp	218	33 (15.1)	166 (76.1)	54 (24.8)	74 (33.9)	63 (29.0)	121 (55.5)	182 (83.5)
Pseudomonas aeruginosa	115	63 (54.8)	86 (75.0)	69 (60.0)	112 (97.4)	63 (54.8)	106 (92.2)	104 (90.4)
Staphylococcus aureus	107	32 (29.9)	1 (0.9)	19 (17.7)	-	71 (66.3)	71 (66.3)	89 (83.2)
Staphylococcus epidermidis	98	0 (0)	0 (0)	0 (0)	-	30 (30.1)	30 (30.1)	49 (50.0)
Citrobacter spp	40	0 (0)	40 (100)	0 (0)	0 (0)	0 (0)	40 (100)	40 (100)
Staphylococcus saprophyticus	39	8 (20.5)	4 (10.2)	20 (51.3)	-	6 (15.4)	28 (71.8)	19 (48.7)
Streptococcus spp	102	18 (17.6)	11 (10.8)	15 (14.7)	-	50 (49.0)	33 (32.3)	33 (32.3)
Enterobacter aerogenes	78	38 (48.7)	35 (44.9)	36 (46.1)	36 (46.1)	3 (3.8)	73 (93.5)	73 (93.6)
Total	3196	817	707	1024	1417	672	2178	2370

GEN: Gentamicin; FM: Nitrofurantoin; CIP: Ciprofloxacin; NA: Nalidixic; SXT: Trimethoprim-sulfamethoxazole; AN: Amikacin; CF: Cephalition; AM: Ampicillin

The difference between this study and the present one can be attributed to the large sample size of the present study.

In most studies carried out worldwide, E. coli has been referred to as the most common cause of UTI.[7,8] In the present study, E. coli with a rate of 68.9% was the most common organism isolated from the urine culture. Other isolated bacteria were respectively Klebsiella spp., Enterococcus spp., Pseudomonas spp., Staphylococcus aureus, Staphylococcus epidermidis, Enterobacter aeruginosa, Citrobacter spp., and Staphylococcus saprophyticus. The order of the pathogens is different in various studies.[9] However, most isolated bacteria belong to Enterobacteriaceae family followed by the gram-positive cocci. In this regard, the results of the present study are in agreement with the reports published in other countries.[10] Since most bacteria naturally live in the intestine, the urinary tract may be infected in this way.[5] Moreover, the number of women with UTI was remarkably higher than men, which is in line with the results of other studies.[5] Short urethra and its proximity to the anus are the main causes of increased UTI among women, while the urethra anatomic system among men and secretion of bactericidal material from the prostate play a significant role in preventing such infections.[6]

According to the results of antibiogram test in the present study, the highest rate of antimicrobial resistance was related to ampicillin as 74.2% followed by cephalothin and cotrimoxazole with respectively 54.0% and 68.1%, respectively. In addition, the most bacterial susceptibility belonged to amikacin, nitrofurantoin, and gentamicin with a rate of 79.0%, 77.8%, and 74.5%, respectively. In the previous study in the northwest region of Iran, Farajnia et al. reported that the highest rate of resistance was respectively related to ampicillin, co-trimoxazole, and cephalexin with 90.7%, 51.8%, and 26.5%, respectively. Moreover, the most bacterial susceptibility respectively belonged to amikacin, ciprofloxacin, and gentamicin as 96.6%, 95.1%, and 92.9%, respectively.[4]

Although the results show that antibiotic resistance pattern was maintained to some extent, comparing the results of these two studies carried out in two different periods of time indicates an increasing trend in antibiotic resistance. This means that the bacteria have become more resistant to most of the antibiotics except for ampicillin with time. Lack of use of ampicillin in recent years may have caused a decrease in resistance of the bacteria causing UI to this antibiotic. Furthermore, excessive consumption of ciprofloxacin has increased bacterial resistance and decreased the effectiveness of this drug. Moreover, the results of another study conducted in the northwest of Iran by Rezaee and Abdinia showed lower resistance of gram-negative and gram-positive uropathogens to amikacin and then ciprofloxacin, in addition, the most uropathogenic E. coli isolates were susceptible to nitrofurantoin. In addition, the results of this study indicated higher resistance rates to all antibiotics tested especially against third-generation cephalosporins and co-trimoxazole.[11] This result is in agreement with present study. According to the results reported by Mukherjee et al., the highest rate of susceptibility was related to nitrofurantoin and amikacin. In addition, the highest rate of resistance belonged to ampicillin, nalidixic acid, cephalexin, amoxicillin, co-trimoxazole, and ciprofloxacin, respectively.[12]

In another study carried out by Teichman et al. on the resistance of bacteria causing UTI, it was concluded that the isolated bacteria had the highest bacterial resistance to ampicillin and co-trimoxazole as 57.4% and 44.7%, respectively.[13] In the study conducted by Chandravathi and Senthilkumaran, amikacin was introduced as a sensitive drug, and ampicillin and ciprofloxacin had the highest rate of bacterial resistance.[14] The results of the present study and those of similar studies show that the rate of antibiotic resistance is different in various geographical regions of the world.

Hence, it can be generally concluded that the emergence of resistant strains has an increasing trend.[4,15]

Conclusion

Inappropriate administration, spontaneous use, and prolonged periods of using a series of antibiotics are among the most important causes of antibiotic resistance; therefore, increasing antibiotic resistance has become a serious threat, and it is necessary to understand correct patterns of using prescribed antibiotics and identify appropriate treatment strategies in every region of the country to resolve this problem. Moreover, it is recommended that training courses and different conferences to be held for general practitioners on the rational prescription of antibiotics to enhance the awareness of individuals in order to prevent

spontaneous use of antibiotics.

Conflict of Interest

Authors have no conflict of interest.

Ethical Approval

Not indicated.

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