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ETIOLOGIC AGENTS AND DRUG SENSITIVITY IN URINARY TRACT INFECTIONS: A SURVEY OF 786 URINE CULTURES

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ABSTRACT

In this survey, 786 urine cultures were studied retrospectively at Shaheed Dr. Rahnamoon Hospital in Tehran. The study showed that *E. coli* is the most common causative agent of urinary tract infections in both sexes, being responsible for 72% of all cases. Other etiologic microorganisms, in order of frequency, were Staphylococcus, Proteus, Klebsiella, Enterobacter and diphteroids. Approximately 9% of all causative microorganisms were partially or totally resistant to the antimicrobials used in the antibiograms and practically all were among the nosocomial infections. The sensitivity/resistance ratio of the etiologic agents in this study revealed that *E. coli* was most sensitive to amikacin, nitrofurantoin and nalidixic acid. However, it was resistant to ampicillin in 90% of all cases (compared to only 30% resistance rate in the western countries), which is probably due to inappropriate use of antibiotics in our country. We therefore conclude that the administration of ampicillin and co-trimoxazole, the two antimicrobials frequently used as an impirical therapy for urinary tract infections, is not appropriate.
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INTRODUCTION

Urinary tract infection is one of the most common infections in man and accounts for many office visits and hospitalizations worldwide.[1,2] Microbiologically, urinary tract infection exists when pathogenic microorganisms are detected in the urinary tract.[1,3] In actuality, the infection is considered significant and requires treatment when a growth of more than 10^5 microorganisms per milliliter from a properly collected mid-stream ("clean-catch") urine specimen is present.[1-3] Urinary tract infection is subdivided into acute and chronic, lower and upper (pyelonephritis), catheter-associated (nosocomial) and non-catheter associated (community acquired) infections.[1,2,5] It can also be symptomatic and asymptomatic. The increased risks for urinary tract infections include sexually active young females, pregnancy, prostatitis, benign prostatic hypertrophy, urinary tract obstruction, calculi, urinary

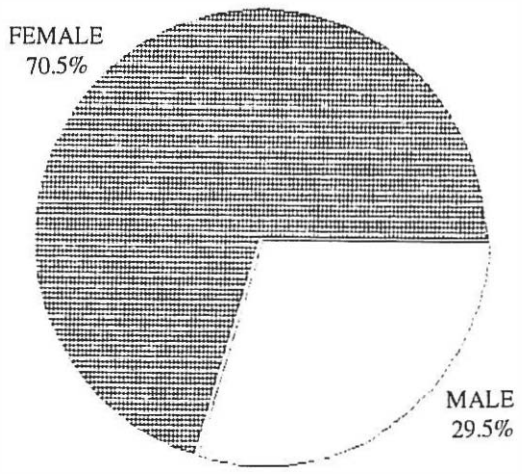


Fig. 1. Female/male ratio of the positive urine cultures in 786 cases.

Table I. The incidence of the pathogenic microorganisms in UTI according to gender in hospitalized, OPD, and pediatric patients

Pathogenic organisms	Hos		OPD.		Ped		number of patients and%
	F	M	F	M	F	M	
E. coli	24	10	25	7	5	5	76(72.4%)
Staph.	3	1	4	-	1	2	16(15.2%)
Proteus	2	-	1	1	-	1	5(4.8%)
Klebsiella	1	1	-	-	1	1	4(3.8%)
Enterobacter	1	1	-	-	-	-	3(2.9%)
Diphtheroids	-	-	1	1	-	-	1(0.9%)
total	36	13	31	9	7	9	1(0.9%)

tract instrumentation and vesico-ureteral reflux.

The urinary tract can be infected by many different microorganisms. *E. coli* is the most common microorganism causing urinary tract infection in the absence of urologic abnormality, obstruction or calculi.[1,2,4] Other gram-negative bacilli such as proteus, klebsiella, enterobacter, serratia and pseudomonas are usually detected in recurrent infections, especially in association with stones, obstruction, urologic manipulation and nosocomial catheter-associated infections.[1,5] *Staphylococcus saprophyticus* accounts for 10 to 15 percent of acute urinary tract infections in young females.[1,7] *Staph. aureus* and enterobacter are the etiologic agents in patients with previous instrumentation and renal stones. Other microorganisms such as *Chlamydia trachomatis*, *Neisseria gonorrhea* and *Herpes simplex* virus, are sexually transmitted infections.[4,7] Colonization of candida and other fungi may occur in diabetics and catheterized patients, and in some instances may cause acute symptomatic infection.[1,2]

To direct therapy of the urinary tract infection, microbial sensitivity tests should be used. Based on the test results, drugs that are usually administered include trimethoprim-sulfamethoxazole, amoxicillin, ampicillin, aminoglycosides, cephalosporins, nalidixic acid and nitrofurantion.[7,8]

METHODS AND MATERIALS

Seven hundred and eighty six urinary cultures were studied retrospectively during a period of six months at Shaheed Dr. Rahnamoon Hospital in Tehran. There were 10^5 positive cultures with a colony count of more than 10^5. To differentiate nosocomial from community-acquired urinary tract infections, the patients were initially divided into two groups of out-patients and in-patients. The in-patient group was subsequently subdivided into adult and pediatric groups. Seventy four patients with positive cultures were female and thirty one were male. The number of

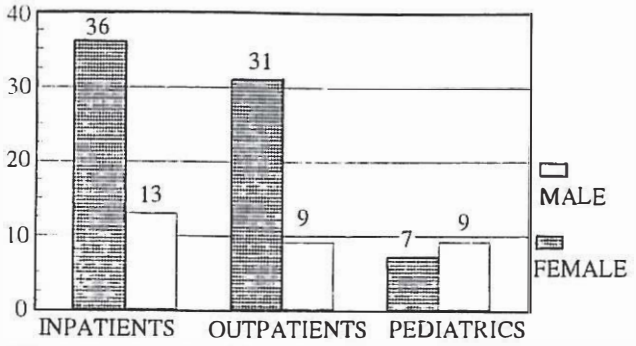


Fig. 2. Number of positive urinary cultures in the adults (inpatients & outpatients) and pediatric group inpatients.

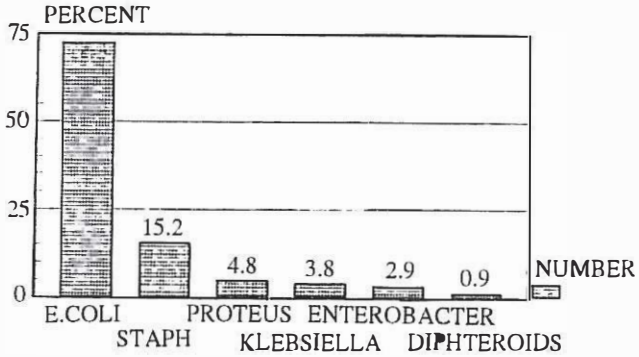
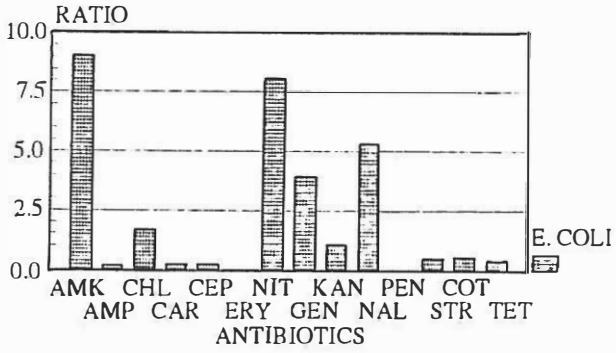


Fig. 3. The percentage of the pathogenic organisms causing urinary tract infections in 105 cases.



AMK = amikacin
AMP = ampicillin
CHL = chloramphenicol
CAR = carbenicillin
CEP = cephalothin
ERY = erythromycin
NIT = nitrofurantion
GEN = gentamicin
KAN = kanamycin
NAL = nalidixic acid
PEN = penicillin
STR = streptomycin
COT = cotrimoxazol (TMP-SMX)
TET = tetracycline

Fig. 4. Sensitive/resistance ratio of *E. coli* for 14 tested antimicrobials.

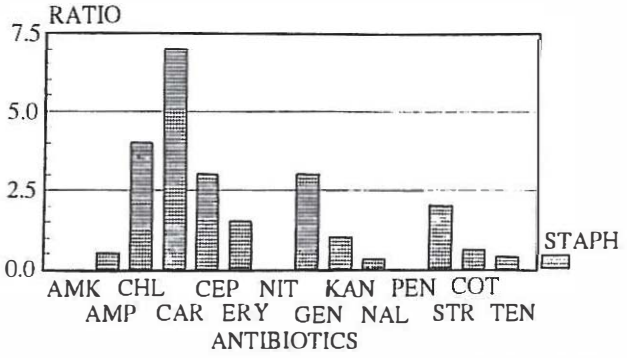


Fig. 5. Sensitive/resistance ratio of Staph. for 14 tested antimicrobials.

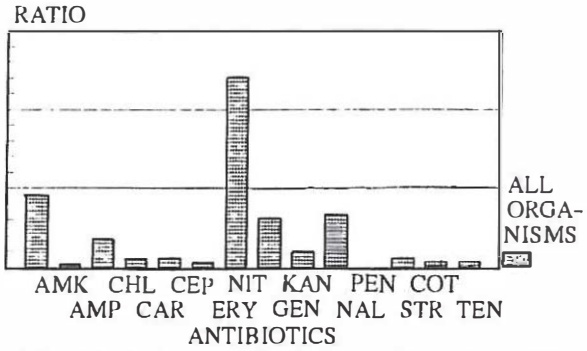


Fig. 6. Sensitive/resistance ratio of all organisms for 14 tested antimicrobials.

adult in-patients was 329 with 49 (15%)positive cultures; the number of adult out-patients was 323 with 40 (12.4%) positive cultures. In the pediatric group, there were 137 out-patients with 16 (11.7%) positive cultures and 16 in-patients.

The mediums used for the cultures were blood agar, MacConkey (EMD) agar and differentiating culture medium of TSI, SIM, urea, MRVP and SS.

DISCUSSION

Out of 786 urinary cultures, 105 instances (13.4%) were positive with colony counts of more than 10^5. The number of women with positive urinary cultures was 74 (70.5%), and thenumberof men showing positive cultures was 31 (29.5%), indicating a significantly higher incidence of urinary tract infections among females, with a female to male ratio of 2.4: 1 (Fig. 1). Separating the figures, it shows again a higher incidence of UTI among females in both hospitalized and out-patient groups. The ratios were 2.8: 1 (hospitalized women/men) and 3.4: 1 (out-patient women/men). This ratio declined, even reversed, in the pediatric in-patient group (0.8: 1 f/m), especially among newborns. This is compatible with studies of other countries (Fig.2).[1] The study shows that *E. coli* is the most common causative agent of UTI in both sexes, being responsible for 72% of all instances. Other etiologic microorganisms, in orderof frequency, were *Staphylococcus* (15.20%), *Proteus* (4.8%), *Klebsiella* (3.8%), *Enterobacter* (2.9%) and diphteroids (0.9%) (Fig. 3. Table I). The study also showed that *E. coli* was more common among the out-patients (80%), thereby placing it in the community-acquired infection classification. Staphylococci and other bacteriae were seen more commonly in the in-patient group, placing it in the nosocomial infection classification. Results of the drug sensitivity and resistance test in this study show:

1. *E. coli* was resistant to ampicillin in 90% of the instances (65 from a total of 72 cases), but it was most sensitive to amikacin, nitrofurantion and nalidixic acid, in the order of better efficacy.

2. *Staphylococcus*, including coagulase-positive and coagulase-negative, was found to be most sensitive to carbenicillin, chloramphenicol and cephalothin, but was partially or completely resistant to penicillin, nalidixic acid and tetracyclines.

3. As a whole, the most effective antimicrobial agents in decreasing order were nitrofurantoin, amikacin and nalidixic acid. On the other hand, microorganisms were most resistant to penicillin, ampicillin, erythromycin, tetracyclines, co-trimoxazole (TMP-SMX), carbenicillin, streptomycin, kanamycin and cephalothin in decreasing order. The sensitive/resistant ratios of the etiologic microorganisms to different antimicrobial drugs are shown in Table II and in Figs. 4-6. The antibiograms revealed that 9.5% of all detected microorganisms were partially or completely resistant to all antimicrobials used in the test; 80% of which showed intermediate sensitivity to some and the remaining 20% were totally resistant to all antimicrobials. The study showed again that 90% of the resistant cases were among nosocomial infections. Drug resistance of various etiologic microorganisms of UTI according to gender is shown in Table III, which indicates:

1. The resistant *E. coli* were detected more frequently in males (80%).

2. The resistantstaphylococci (coagulase-positive) were more prevalent among females.

3. *E.coli* and staphylococci accounted for 90% of the resistant microorganisms. Proteus-induced UTI was found resistant to all of the antimicrobials in only one instance.

4. Practically all resistant microorganisms were among the hospital-acquired infections.

CONCLUSION

In this survey, the results of 786 urine cultures were studied retrospectively. Thirteen percent of the cultures were positive with a colony count of greater than 10^5 and

Table II. Sensitive/ resistance ratio for 14 antimicrobial agents used in the antibiograms

antimicrobials	AMK	AMP	CHL	CAR	CEP	ERY	NIT	GEN	KAN	NAL	PEN	STR	COT	
E. coli	9	0.11	1.68	0.21	0.21	0	8	3.86	1	5.25	0	0.38	0.45	0.27
staph.	-	0.5	4	7	3	1.5	-	3	1	0.3	0	2	0.6	0.4
all microorganisms	4.5	1.16	1.76	0.41	0.56	0.24	12	3.1	0.89	3.25	0	0.5	0.4	0.35
no. of tests	10	72	51	34	51	15	18	68	50	50	8	"	68	61

Table III. The incidence of sensitivity and resistance of the different causative microorganisms according to gender

microorganisms	sensitive		resistant		
	male	female	male	female	
E. coli	18	53	4	1	76
Staph. coag-	2	7	-	-	9
Staph. coag+	-	3	1	3	7
Proteus	2	2	-	1	5
others	4	4	-	-	8
total	26	69	5	5	105

with a prevalence rate of about 70% for females and 30% for males. *E. coli* was the most common causative microorganism, being responsible for 72% of the UTIs, followed by *Staphylococcus* (including coagulase positive and negative), with an incidence of 15%. Other microorganisms such as *Proteus*, *Klebsiella*, *Enterobacter* and *P Seudomonas* were the etiologic agents in about 12% of the instances. *E. coli* and Staphylococci induced UTIs were more common in females, but the infections caused by other microorganisms were more common in males. About 9% of all causative microorganisms were partially or totally resistant to the antimicrobials used in the antibiograms. The most common resistant microorganisms were among the nosocomial infections. The sensitive/resistant ratios of the different microorganisms in this study revealed that *E. coli* was most sensitive to amikacin, nitrofurantoin and nalidixic acid, in decreasing order, while it was resistant to ampicillin in 90% of all cases, compared to about 30% resistance rate in the western countries,[9] which is probably due to improper use of antibiotics in this country. Co-trimoxazole (TMP-SMX) also had a very low sensitivity/resistance ratio. We therefore conclude that the administration of ampicillin and co-trimoxazole, two antimicrobials frequently used as empirical therapy, is not appropriate (while the results of antibiograms are pending). Again based on sensitivity/resistance ratios in this survey, usage of amikacin as an empiric parenteral therapy for more severe infections and nalidixic acid and nitrofurantoin as empiric oral therapies for milder infections appear to be logical.

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