SHORT COMMUNICATION

Urinary Tract Infections: Bacteriology and Antibiotic Resistance Patterns

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The aim of this study was to identify the bacteria causing community acquired urinary tract infections (UTI) and detection of antibiotics resistance of isolates in 912 children below 18 years in the west of Iran. Data were analyzed for 4 age groups: infants, toddlers, preteens and teens. Fourteen antibiotics were tested by gel-diffusion method. Of 912 patients, 34.2% had positive bacterial cultures. The most common isolates were *E. coli* (57.4%), *K. pneumoniae* (9.7%), *S. aureus* (5.8%) and *A. baumannii* (2.2%). Most isolates showed high resistance against ampicillin, cotrimoxazole, nalidixic acid, tobramycin and nitrofurantoin. *Klebsiella isolates* showed more resistance against tested antibiotics than *E. coli* isolates.

Keywords: Antibiotics, Iran, Resistance, Urinary tract infection.

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Community acquired urinary tract infections (UTI) cause significant illness in the first 2 years of life and are considered as common disease in school and pre-school children, particularly in our country(1-3). Etiologic agents of UTI are variable and usually depend on time, geographical location and age of patients. However, Enterobacteriacea species including *Escherichia coli, Proteus mirabilis, Enterobacter agglomerans, Citrobacter freundii* and *Klebsiella pneumoniae* account for over 70% cases(2-5).

Based on the microbial sensitivity test results, drugs that are usually administered against uropathogens include cotrimoxazole, amoxicillin, ampicillin, aminoglycosides, cephalosporins, nalidixic acid and nitrofurantoin. However, many reports have indicated the presence of multi-drug resistance in organisms causing UTI(6-9). Prior to this study, the antibiotic susceptibility of isolates has not been previously determined in this region. Therefore, the aim of this study was to identify the most common bacteria causing UTI and detection of antibiotic susceptibility of isolates in children.

METHODS

A cross-sectional study was performed on 912 children with UTI admitted to the pediatric department of hospital of Ekbatan in Hamadan, in the west of Iran, between March 2004 and April 2006. Only patients who had pyuria (>10 white blood cells/μL), acute voiding symptoms and significant bacteriuria (>10^5 CFU/mL) were included in the microbiological analysis. Data were analyzed separately for four age groups: infants (0-4 weeks), toddlers (5 weeks-24 months), preteens (2-12 years) and teens (13-18 years). Urine collection, culture and identification of organisms were performed as per methods outlined in standard text(2,10).

Susceptibility testing was performed by VITEK

(BioMérieux, Inc.) automated system for Enterobacteriaceae. Disk diffusion test (Oxoid, Basingstoke, Hampshire, UK) was used for Gram-positive bacteria and *P. aeruginosa*. Fourteen antibiotics of different classes (***Table* I**) were tested against isolates. Interpretative criteria for antimicrobials tested were those recommended by NCCLS guidelines(11). *E. coli* ATCC 25922, *S. aureus* ATCC 25923 and *P. aeruginosa* ATCC 27853 were used as quality controls.

RESULTS

Of 912 children, 34.2% had positive cultures. The most common isolates were *E. coli* (57.4%), *K. pneumoniae* (9.7%), *E. aerogenes* (7.0%), *S. aureus* (5.8%), *C. fruendii* (5.1%), *P. mirabilis* (4.5%), *P. aeruginosa* (3.2%), *A. baumannii* (2.2%), coagulase-negative *Staphylococcus* (3.2%) and *E. fecalis* (1.9%). The most common age were teens (49.6%), preteens (26.8%), toddlers (15.0%) and infants (8.6%), respectively. Most gram-negative isolates were found in toddlers and preteens patients, whereas most gram-positive cocci, particularly *E. faecalis* isolates were found in teen patients. *Acinetobacter baumannii* isolates were found mostly (85%) in preteen patients.

The antimicrobial potency of 14 selected antimicrobial agents against the two most frequent uropathogens (*E.coli* and *K. pneumoniae*) are summarized in ***Table* I**. Among β-lactam antibiotics, imipenem had the widest coverage against *E. coli* isolates. *E. coli* resistance to ampicillin peaked in preteens (76.4%) but was high in teens (65.7%), toddlers (53.4%), and infants (47.6%). Resistance to cotrimoxazole peaked in teens (68.3%) but was high in preteens (59.1%), infants (49.4%) and toddlers (47.6%). *Klebsiella* isolates also showed high susceptibility against imipenem. Antibiotic resistance patterns of other isolates are shown in ***Table* II**. Among gram negative bacteria, *P. aeruginosa* was most resistant isolates against tested antibiotics. Among gram positive cocci, *E. fecalis* isolates showed highest resistance followed by *Staphylococcus* isolates. Resistance to two or more antibiotics varied across age groups; teens (36.1%), preteens (33.1%), infants (29.7%) and toddlers (24.9%).

DISCUSSION

This is the first study to evaluate the bacteriology and susceptibility patterns of bacteria isolated from children with UTI in west of Iran. The present study

TABLE I ANTIBIOTICS RESISTANCE IN *ESCHERICHIA COLI* AND *KLEBSIELLA PNEUMONIAE* IN CHILDREN WITH UTI

	Escherichia coli (*n*=179)			*Klebsiella pneumoniae* (*n*=30)		
Antibiotics	Resistance (%)	Intermediate (%)	Susceptible (%)	Resistance (%)	Intermediate (%)	Susceptible (%)
Imipenem	0.0	2.3	97.7	6.6	3.3	90.1
Netilmicin	2.3	1.1	96.7	16.6	0.0	83.4
Aztreonam	3.4	3.9	92.7	13.3	6.6	80.1
Cefepime	4.5	2.3	93.2	9.9	3.3	86.8
Ciprofloxacin,	5.5	1.1	93.4	23.3	0.0	72.7
Amikacin	6.1	0.0	93.9	36.6	3.3	60.1
Ceftriaxone	7.8	2.3	89.9	9.9	6.6	83.5
Coamoxiclav	11.1	5.5	83.4	9.9	0.0	90.1
Gentamicin	18.8	3.9	77.3	43.3	6.6	50.1
Tobramycin	22.2	5.0	72.8	39.9	13.2	46.9
Nitrofurantoin	42.1	6.1	51.8	47.3	6.6	46.1
Nalidixic acid	43.6	0.0	56.3	46.6	9.9	43.5
Cotrimoxazole	56.4	2.9	40.7	63.2	16.5	20.3
Ampicillin	61.9	2.0	36.1	96.6	3.3	0.0

WHAT THIS STUDY ADDS?

- In children with culture positive UTI in Hamadan, Iran, *E. coli* and *K. pneumoniae* were the predominant uropathogens, sensitive to imipenem, netilmicin, cefepime and ciprofloxacin.

showed that the rate of UTI (34.2%) among children was more than that reported previously(1,2,4-6, 12). Entrobactericae isolates were the dominant bacterial agents, in agreement with previous works(4-6,12, 13). *E. coli* was the commonest isolate, particularly among the toddlers and preteens patients. *K. pneumoniae* was the second most common uropathogen and was dominant in teens. Gram-positive cocci had low contribution in causing UTI.

This study provides valuable laboratory data on antibiotics susceptibilities of uropathogens and allows comparison of the situation in our area with that in other countries. A limitation of this study was that some antibiotics such as fluoroquinolones and cephalosporins were not available at the time of sensitivity testing. On the basis of reports by Antimicrobial Surveillance Program, isolates from Canada, USA and Latin American countries show the lowest susceptibility rates to most antimicrobial agents followed by Asian-Pacific isolates and European strains(8,9,13,14). Of 14 tested antibiotics in this study, the most active antibiotics against all gram-negative isolates were imipenem, netilmicin, aztreonam, cefepime and ciprofloxacin. Most of these isolates showed high resistance against ampicillin, cotrimoxazole, nalidixic acid, tobramycin and nitrofurantoin. The inadequate dosage of these antibiotics used during self-medication in our community is likely to be a factor contributing to the development of resistant strains. These findings are similar to studies from Africa, South-Asia and some Middle East countries(6,7,12,13,15).

Klebsiella isolates in this study showed more resistance than *E. coli* isolates. The major difference was observed for gentamicin and amikacin; *E. coli* isolates showed low resistance to amikacin and gentamicin, while *Klebsiella* isolates showed high resistance to these agents despite being sensitive for many years(2,8,14).

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TABLE II ANTIBIOTIC SUSCEPTIBILITY PATTERNS OF OTHER BACTERIA IN CHILDREN WITH UTI

Isolate	Frequency of resistance of isolates to antibiotics (%)													
	IMP	NET	AZN	CEF	CIP	AMK	CFX	NIT	AMC	GEM	TOB	NAL	COT	AMP
E. aerogenes	9	0	4.5	9	18	4.5	9	18	0	9	27	22	36	54
S. aureus	22	11	–**	16	33	33	44	55	11	44	55	66	83	94
C. freundii	0	12	0	6	0	12	6	18	24	12	6	0	12	18
P. mirabilis	0	0	14	0	14	7	7	21	21	0	14	28	42	35
P. aeruginosa	30	10	50	30	70	20	80	100	80	60	60	70	90	100
CONS	40	10	–	10	60	80	60	80	40	70	40	60	70	80
A. baumannii	14	14	28	0	57	28	21	28	0	14	21	71	14	71
E. fecalis	50	33	–	16	33	50	66	50	66	50	16	66	83	100

*Imipenem (IMP), netilmicin (NET), aztreonam (AZN), cefepime (CEF), ciprofloxacin (CIP), amikacin (AMK), ceftriaxone (CFT), nitrofurantoin (NIT), coamoxiclav (AMC), gentamicin (GEM), tobramycin (TOB), nalidixic acid (NAL), cotrimoxazole (COT), ampicillin (AMP). ****Not tested for gram-posirive cocci; CONS: Cogulase negative staphylococci.*

REFERENCES

1. Schlager T. Urinary tract infections in infants and children. Infect Dis Clin North Am. 2003; 17: 353-365.
2. Wald ER. Cystitis and pyelonephritis. In: Feigin RD, Chery JD, Demmier GJ, Kapian SL, eds. Textbook of Pediatric Infectious Diseases, 5th edn, Philadelphia: Saunders 2004; p 541-53.
3. Fallahzadeh MH, Alamdarlu HM. Prevalence of urinary tract infection in pre-school febrile children. Iranian J of Med Sci 1999; 24: 35-39.
4. Ma JF, Shortliffe LM. Urinary tract infection in children: etiology and epidemiology. Urol Clin North Am 2004; 3: 517-526.
5. Adjei O, Opoku C Urinary tract infections in African infants. Int J Antimicrob Agents 2004; 24 Suppl 1: S32-34.
6. Yüksel S, Oztürk B, Kavaz A, Ozçakar ZB, Acar B, Güriz H, *et al*. Antibiotic resistance of urinary tract pathogens and evaluation of empirical treatment in Turkish children with urinary tract infections. Int J Antimicrob Agents 2006; 28: 413-416.
7. Yildiz B, Kural N, Durmaz G, Yarar C, Ak I, Akcar N. Antibiotic resistance in children with complicated urinary tract infection. Saudi Med J 2007; 28: 1850-1854.
8. Mathai D, Jones RN, Pfaller MA. SENTRY Participant Group North America. Epidemiology and frequency of resistance among pathogens causing urinary tract infections in 1,510 hospitalized patients: a report from the SENTRY Antimicrobial Surveillance Program (North America). Diagn Microbiol Infect Dis 2001; 40: 129-136.
9. Kahlmeter G. Prevalence and antimicrobial susceptibility of pathogens in uncomplicated cystitis. The ECO SENS study. Int J Antimicrob Agents 2003; 22: 49-52.
10. Forbes BA, Sahm DF, Weissfeld AS. Bailey & Scott's Diagnostic Microbiology, 11th edn. Philadelphia: Mosby 2002: pp.133-148 and 907-912.
11. Clinical and Laboratory Standard Institute. Performance standards for antimicrobial disk susceptibility tests. NCCLS documents M 100 S15. Wayne, PA, USA: Clinical and Laboratory Standard Institute; 2005.
12. Tessema B, Kassu A, Mulu A, Yismaw GP. Predominant isolates of urinary tract pathogens and their antimicrobial susceptiblity patterns in Gondar University Teaching Hospital, northwest Ethiopia. Ethiop Med J 2007; 45: 61-67.
13. Akram M, Shahid M, Khan AU. Etiology and antibiotic resistance patterns of community-acquired urinary tract infections in JNMC Hospital Aligarh, India. Ann Clin Microbiol Antimicrob 2007; 6: 4.
14. Kiffer CR, Mendes C, Oplustil CP, Sampaio JL. Antibiotic resistance and trend of urinary pathogens in general outpatients from a major urban city. Int Braz J Urol 2007; 33: 267-269.
15. Randrianirina F, Soares JL, Carod JF, Ratsima E, Thonnier V, Combe P, *et al*. Antimicrobial resistance among uropathogens that cause community-acquired urinary tract infections in Antananarivo, Madagascar. J Antimicrobial Chem 2007; 59: 309-312.