The microorganism and underlying urological anomalies causing the urinary tract infection in the children attended the pediatric surgery clinic at the maternity and children teaching hospital al-qadisiya\ iraq.

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الملخص

ع د خم ج المس لك البولي ة م ن الخم ج الش ائع ل دى الاطف ال والذي يس بب مش اكل مرض ية عدي دة بالرغم من استعمال الكثير م ن المض ادات الحياتي ة الفعال ة تم ت دراس ة 110 حال ة طف ل مص اب بخم ج المس الك البولي ة في وح دة جراح ة الاطفال ش ا في النس ائية والاطف ال التعليم ي ف ي محافظة الديوانية للفترة من الاول من اب 2005 م الى نهاية تموز 2008م لبيان انتشار تش وهات المسالك البولية وعها والكائن الح ي المجه ري المس بب للخم ج المص احب بوج ود التش وه م ن عدمه. كان عدد الاناث 78 (70.9%) والذكور 32 (29%) شكلت نسبة الفئ ة العمري ة م ن 1-5 سنة ، 68 (61.8%) من الاصابات الاعلى بين الفئات العمرية ظهرت تش وهات المس الك البولي ة عند 47 (42.7%) من المرضى لان م نعكس المثان ة للحال ب النس بة الاعل ى 16 (34%) م ن مجم وع التشوهات وهابتكتري ا القول ون ه ي المس بب المرض ي الاكثر شيوعا عن د المص ابين وشكلت (61.3%) مجموع عزلات الوسائط الزرعي ة ل دى الجنس ين والت ي كان ت موجب ة عن د 44 (40%) من المرضى المص ابين. رت الدراس ة بع دم وج ود اخ تلاف معن وي ف ي المس بب المرضي بين المرضى المصابين مع وجود التشوه الخلقي للمسالك البولية او عدمه.

Abstract

Urinary tract infections (UTI) are among the most common infections in children. UTI related morbidity remains high despite the use of numerous effective antibacterial agents . The sample of this study was conducted in the pediatric surgery unit at the Maternity and Children Teaching Hospital , Al-Diwaniya (Iraq) and from the 1st of August 2005 to the end of July 2008. All the patients presenting with UTI to the outpatient clinic or to the surgical ward were investigated prospectively . The aim of this study was to determine how many patients had underlying urological abnormalities, the specific type of abnormality, and the microorganism causing the UTI in the patients with or without urological anomalies.There were 78 (70.9%) girls and 32 (29%) boys , 19 (17.2%) were between 0-1 year, 68 (61.8%) were at an age between 1-5 years, and 23 (20.9%) were more than 5 years of age. Forty seven (42.7%) of these patients had abnormal urological findings. Of 78 girls, 31 (39.7%) had urological abnormalities.

Sixteen children had VUR as an only abnormality. The distribution of abnormalities showed some changes by age and sex. Bacteriuria (>10^5 bacteria per milliliter of urine) was found in 44 (40%) of patients. The most common bacterial agent of urinary infections was *E. coli* (61.3%) of total isolates in both sexes , it was the most common pathogen among all patients (those with urological abnormalities and those without). There was no difference in the distribution of microorganisms in patients with and without urological anomalies. The diagnosis of UTI in young children is important as it is a marker for urinary tract abnormalities. A child with a suspected UTI should have a urine culture and colony count performed in order to identify organisms for confirmation of diagnosis and recommend prompt treatment to reduce UTI related morbidity and mortality in children.

Introduction

Urinary tract infections (UTI) are among the most common infections in children. UTI related morbidity remains high despite the use of numerous effective antibacterial agents [1]. It is important to follow UTI closely because it may be an indicator of a serious, underlying urological abnormality requiring early medical intervention or it may lead to chronic pyelonephritis, which is one of the major causes of end–stage renal failure in children [1,2]. Studies in Western countries suggested that it accounted for 5% of febrile illnesses in young children[3]. It is especially common in infants, female and the white race[4]. Imaging studies following UTI revealed a high incidence of abnormalities in the renal tract, with vesicoureteric reflux (VUR) in 30-50%1 and obstructive uropathies in 1-4%.3 Evidence of renal parenchymal damage was present in 1.6-15% as seen on intravenous urography [5] and 59% as seen on 99m technetiumdimercaptosuccinic acids (DMSA) scans [6] The risk of renal scarring was positively associated with the severity of VUR and number of recurrent febrile UTI. Infection may occur at many places along the genitourinary tract: urethra, bladder, ureter, renal pelvis, or renal parenchyma[3,7] It is assumed that the short urethra in girls predisposes them to ascending infection, because, for example Escherichia coli serotypes from bowel flora are the same as those that infect the urinary tract. However, factors other than the proximity of gut flora to the short urethra are likely because the female to male ratio in urinary tract infection varies directly with age [3,8]. Most infections are due to colonic bacteria and are due to invasion up the urethra. Of these, E.coli is by far the most commonly isolated organism, being responsible for approximately 80% of UTIs[9].

E.coli has recognized virulence factors which aid in the persistence of bacteria in the urinary tract and induce inflammation. Such factors include the presence of pili or fimbriae, K antigen in bacterial capsule, haemolysin and colicin production and the ability to acquire iron etc[9].Microbiologically, urinary tract infection exists when pathogenic microorganisms are detected in the urinary tract[10.11]. The infection is considered significant and requires treatment when more than 105 microorganisms per milliliter of urine are present in a properly collected specimen[10,11]. Gram-negative bacteria such as E. coli, Proteus spp., Klebsiella spp., Enterobacter spp., Serratia spp. and Pseudomonas spp. are usually detected in recurrent infections, especially in association with stones, obstruction, urologic manipulation and nosocomial catheter-associated infections[10,12,13] .

The aim of this study was to determine how many patients had underlying urological abnormalities, the specific type of abnormality, and the microorganism causing the UTI in the patients with or without urological anomalies .

Patients and Methods

The sample of this study was conducted in the pediatric surgery unit at the maternity and Children Teaching Hospital , Al-Qadisiya - Al-Diwaniya , (Iraq) and from the 1st of August 2005 to the end of July 2008, all the patients presenting with UTI to the outpatient clinic or to the surgical ward were investigated prospectively . This is a study of 110 children with urinary tract infection (UTI) evaluated for the prevalence of urological abnormalities, the specific type of abnormality, and the microorganism causing the UTI in the patients with or without urological anomalies. The study enrolled children aged one day to 15 years, who presented with first proven UTI , inclusion criteria were dysuria, frequency, urgency, and abdominal flank pain with or without fever. Patients receiving antibiotic therapy were excluded from the study. Ultraosonography (US) were performed in all patients , voiding cystourthrography (VCUG) were performed in 58 pateins (four weeks after the documentation of negative urine culture and only if there were abnormal ultrasound findings) , and intravenous pylography (IVP) were performed in 76 patients (in case of abnormal ultrasound findings and because some of the patients had two or more abnormalities, the findings combined both the upper and lower abnormalities) and 8 had computed tomography scans (CT scan) . There were 78 (70.9%) girls and 32 (29%) boys , 19 (17.2%) were between 0-1 year, 68 (61.8%) were at an age between 1-5 years, and 23 (20.9%) were more than 5 years of age. All patients had complete blood count, renal function tests, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), urinalysis, urine culture and sensitivity .

Urine samples were taken either by midstream clean catch technique, catheterization or sticking of a sterile bag according to age and 4 patients were obtained from nephrostomy specimens . One hundred and ten urine samples were obtained from patients and transmitted to microbiology laboratory in about half an hour.

Urine samples were inoculated into the MacConkey and blood agar . The diagnosis of UTI was based on signs and symptoms of UTI such as sepsis in the newborn, fever, abdominal flank pain, dysuria, and urinating frequency and a colony of at least 10^5 organisms/milliter in a midstream, clean–voided specimen, 10^3 or more organisms/milliter in a catheterized urine or any growth in a nephrostomy aspirated urine specimen [1].

Patients with nosocomial UTI were excluded. UTI were considered nosocomial if symptoms occurred and the documenting urine culture was obtained at least 48 hours after hospital admission or previously collected urine specimens revealed no evidence of infection. The medical charts were recorded prospectively, and information regarding the patient's age, sex, and race , results of routine urinalyses and imaging studies , causative microorganisms , frequency of infection , and presence of underlying urological abnormalities was obtained and analyzed . The data were analyzed by Chi-square test or Fisher's exact test where appropriate. A *P* value <0.05 was considered significant.

Results

Of the 110 patients, there were 78 (70.9%) girls and 32 (29%) boys , 19 (17.2%) were between 0-1 year, 68 (61.8%) were at an age between 1-5 years, and 23 (20.9%) were more than 5 years of age (Table-1). All 110 patients had ultrasonographic examinations, 58 also had voiding cystourethrography (VCUG), and intravenous pylography (IVP) were performed in 76 patients and 8 had computed tomography scans (CT scan) . Forty seven (42.7%) of these patients had abnormal urological findings. Of 78 girls, 31 (39.7%) had urological abnormalities. Of 32 boys, 16 (50%) had urological abnormalities. Because some of the patients had two or more abnormalities, we categorized the findings as upper (kidney and ureter), lower (bladder and urethra), combined abnormalities, and vesicoureteric reflex VUR without other abnormalities (Table- 2). Urinary tract abnormalities other than VUR were observed in 21 (44.6%) patients with urological anomalies (Table-3). These included upper (10 of patients had combined abnormalities) ; urolithiasis in 11 (23.4%) (included in others combined anomalies), pelviureteric-junction obstruction in 6 (12.7%) , duplication 2 (4.2%) ,cystic kidney\dysplastic\agenesis 4 (8.5%), horseshoe kidney 1 (2.1%), ureterovesical junction obstruction (UVJO) 1 (2.1%) and ureterocele in 1 (2.1%) .

The lower anomalies (4 of patients had combined anomalies) ; neurogenic bladder 3 (6.3%) , urolithiasis 4 (8.5%) , posterior urethral valve in 2 (4.2%) , bladder diverticulum 1 (2.1%), and urethrocele in 1 patient (2.1%). Sixteen children had VUR as an only abnormality. VUR also occurred in 5 children with upper urological abnormalities, in 3 children with lower urological abnormalities, and in 2 children with multiple abnormalities. Ten girls and 6 boys were found to have VUR . VUR was bilateral in 4 and unilateral in 12. The grading of reflux was grade I in 2 , grade II in 2 , grade III in 5, grade IV in 5 and grade V in 2 respectively. The distribution of abnormalities showed some changes by age and sex (Tables- 3 and Table-4).

Regarding the microbiological results ,of the 110 urine cultures taken, 65 were midstream, clean–voided specimens; 32 were catheter specimens; 7 sticking of a sterile bag and 4 were nephrostomy specimens. Many types of organisms were isolated , The bacteria isolates were identified based on colony morphology characteristics, Gram stain reaction . Bacteriuria (>10^5 bacteria per milliliter of urine) was found in 44 (40%) of patients. Of the 78 females examined , 32 (41%) had positive urine culture while 12 (37.5%) of the 32 males had significant bacteriuria. Ten had infections derived from two organisms. The most common bacterial agent of urinary infections was *E. coli* (61.3%) of total isolates in both sexes , it was the most common pathogen among all patients (those with urological abnormalities and those without). *Proteus* spp. as identified as the causative organism in 21.4% of isolates in boys against 2.2% in girls, which was statistically significant ($P < 0.001$). Other etiologic bacteria among all isolates, in order of frequency were: *Klebsiella* spp. (8%), *Enterobacter* spp. (2.8%), *Pseudomonas aeruginosa* (2.3%), *Staphylococcus suprophyticus* spp. (1.7%) and *Salmonella typhi* (0.3%)(Table-5). There was no difference in the distribution of microorganisms in patients with and without urological anomalies (Table -6, P>0.05).

Table -1: Age and sex distribution of UTI.

Age in year		Male	Female
0-1	19 (17.2%)	7 (36.8%)	12 (63.1%)
1-5	68 (61.8%)	21 (30.8%)	47 (69.1%)
> 5	23 (20.9%)	4 (17.3%)	19 (82.6%)
Total	110	32 (29%)	78 (70.9%)

Table- 2:Findings as upper, lower, combined abnormalities, and vesicoureteric reflex VUR without other abnormalities .

Types of urological anomalies *	Male	Female
Upper - urolithiasis (included in others combined anomalies) 11 (23.4%)	7	4
-Pelvireteric -junction obstruction 6 (12.7%)	3	
- Duplication 2 (4.2%)	2	3
- cystic kidney\dysplastic\agenesis 4 (8.5%)	1	3
- horseshoe kidney 1 (2.1%)		1
- UV junction obstruction 1 (2.1%)		1
- ureterocele 1 (2.1%)		1
Lower (4of patients had combined anomalies)		
- neurogenic bladder 3 (6.3%)	1	2
- urolithiasis 4 (8.5%)	2	1
- posterior urethral valve 2 (4.2%)	2	
- bladder diverticulum 1 (2.1%)		
- urethrocele 1 (2.1%)		1
		1
Total ** 21 (44.6%) of the patients with urological anomalies ***	9 (28.1%) of the male patients	12 (15.3%) of the female patients

*** Some of the patients had two or more abnormalities .**

**** 10 of patients had combined abnormalities 1 male and 9 female.**

***** VUR also occurred in 5 children with upper urological abnormalities, in 3 children with lower urological abnormalities, and in 2 children with multiple abnormalities.**

Tables- 3: The distribution of abnormalities (VUR).

Grade of VUR (N=16)*	Boys (N=6)	Girls (N=10)
I 2	1	1
II 2	0	2
III 5	2	3
IV 5	2	3
V 2	1	1
Unilateral 12	5	7
Bilateral 4	1	3
Total 16 (34%) of urological anomalies	6 (18.7%) of the male patients	10 (12.8%) of female patients

*** VUR also occurred in 5 children with upper urological abnormalities, in 3 children with lower urological abnormalities, and in 2 children with multiple abnormalities.**

Table-4: Age and sex distribution of UTI and the findings as upper, lower, combined abnormalities, and vesicoureteric reflex VUR without other abnormalities.

Age in year	No.of patients & %	Upper anomalies	Lower anomalies	VUR	Combined anomalies with VUR	Total No.& % from the patients in this age
0-1	19(17.2%)	5	3	4	5	17 (89.4%)
1-5	68(61.8%)	4	4	8	4	20 (29.4%)
> 5	23(20.9%)	2	3	4	1	10 (43.4%)
Total	110	11	10	16	10	47 (42.7%) from the total patients

Table-5:The microorganisms among all isolates, in order of frequency, percentage and sex distribution .

Bacterial isolate	Female & % from the total isolate	Male & % from the total isolate	Total & % of total isolate in both sex
E. coli	19 (43.1%)	8 (66.6%)	27 (61.3%)
Proteus spp.	2 (2.2%)	3 (21.4%)	5 (23.6%)
Klebsiella spp.	3	1	4 (8%)
Enterobacter spp.	2	-	2 (2.8%)
Pseudomonas aeruginosa	1	-	1 (2.3%)
Staphylococcus suprophyticus spp.	1	-	1 (1.7%)
Salmonella typhi	1	-	1 (0.3%)
Others*	3	-	3 (6.8%)
Total **	32 (41%)	12 (37.5%)	

*** Others were *Shiegella, Trichomonas,and Chlamydia.***
**** Ten had infections derived from two organisms.**

Table -6: The distribution of microorganism between the patients weth and without urological anomalies.

Types of microorganisms	Patients with urological anomalies & % from total isolate	Patients without urological anomalies & % from total isolate
E. coli	13 (29.5%)	14 (31.8%)
Proteus spp.	2 (4.5%)	3 (6.8%)
Klebsiella spp.	1 (2.2%)	3 (6.8%)
Enterobacter spp.	1 (2.2%)	1 (2.2%)
Pseudomonas aeruginosa	1 (2.2%)	-
Staphylococcus suprophyticus spp.	-	1 (2.2%)
Salmonella typhi	-	1 (2.2%)
Others	1 (2.2%)	2 (4.5%)
Total	19 (43.1%)	25 (56.8%)

Discussion

Although most children with UTI have an excellent prognosis, there is a risk of serious sequeale, which should be considered by physicians, parents and patients. In our study, 89% of our patients were less than 5 years of age and females prevailed among the patients with UTI even in the neonatal period, a finding similar to what was reported in other studies . Our data showed that children with UTI commonly first presented in infancy (79% of our cases). This was in agreement with So and Davies[7] (86% of boys and 60% of girls presenting in the first year), but differed from the report by Chow et al[14] (only 45.5% in the first year). Since the inclusion criteria were similar, the difference may reflect genuine decrease in incidence of UTI in older children because they have been picked up at an earlier age or because of improvement in other risk factors such as constipation and poor toilet habits. In contrast, Hoberman et al reported a female predominance (276 girls versus 33 boys) in their cohort of children in the USA who had UTI below 2 years of age[15]. Similar female predominance were also noted in the metaanalysis by Downs, which showed a prevalence of 3% and 2% in febrile boys below and above 1 year old respectively while the prevalence was 7% and 8% for febrile girls below and above 1 year old respectively[3]. The results of this study show that about 43% of infants and children with symptomatic UTI had associated urological anomalies. Associated VUR were also seen in 14% of patients. These support the idea that nearly all the patients with UTI need a complete imaging work up. We recommend that ultrasound, VCUG and scan should be routinely performed on all patients after the first UTI. DMSA scan unfortunately not available in our hospital . The percentage of the urological abnormalities in boys is higher than girls in our study($p>0.05$). However, most of the studies in literature revealed high rates of urological abnormalities in boys than girls [16,17,18]. Kieley et al [16] evaluated 82 boys and 226 girls with UTI and found that radiological abnormalities are slightly more common among in boys (41.5% vs 36.7%) and more severe than in girls. In the study by Bahna et al [17], 50% of 8 boys and 43.3% of 116 girls with UTI had urological abnormalities. In the series by Burbige et al [18], the incidence of anatomical abnormalities was 75% in 83 boys presenting with first–time UTI.

The prevalence of VUR in children with UTI varies among different racial groups, being highest in white children with symptomatic UTI. Studies from the United States, United Kingdom, and Italy show the highest prevalence of VUR (41%–63%)[19,20,21] . In our study VUR was the most common associated abnormality detected in 16 (34%) patients with urological anomalies of these 10 (12.8%) of the girls and 6 (18.7%) boys.

VUR also occurred in 5 children with upper urological abnormalities, in 3 children with lower urological abnormalities, and in 2 children with multiple abnormalities which form in total 26 (23.6%) of patients . This was similar to findings reported by Howard et al[22], which reported the presence of VUR in 39% of symptomatic Chinese children with UTI. In this study, male patients had a higher frequency of reflux than females (18.7% vs. 12.8%)(P>0.05). VUR which leads to stasis and recurrent infection in children, was the most common abnormality in children with UTI, which is consistent with other reports from other studies[23,24]. Ureteropelvic junction obstruction is the most common congenital renal anomaly and ultrasound is the most sensitive imaging modality for detection of hydronephrosis and hydroureter[25]. In our series associated abnormality other than VUR was detected in 21 (44.6%) cases, renal stone 11 (23.4), obstructive hydronephrosis 6 (12.7%), neurogenic bladder 3 (6.3%), PUV 2 (4.2%) and ureterocele 1(2.1%) of patients with urological anomalies respectively. Ahmadzadeh reported in his series the associated abnormality other than VUR was detected in 26 (21%) cases, renal stone (8%), obstructive hydronephrosis (6.3%), neurogenic bladder 3 (2.3%), PUV 3 (2.3%) and ureterocele 1(0.79%) of his 185 patients managed in this study [26]. Approximately 10% of children are born with congenital abnormalities of the urinary tract. In addition to VUR, which is the most common abnormality, these abnormalities include duplex ureters, uretheral and ureteric obstructions, vesical diverticula, and calculi. The possibility of urological abnormality should always be considered in children presenting with UTI. Duplication of the upper urinary tract is the other most common abnormality in children, and VUR is the abnormality most commonly associated with duplication. The possibility of ureteric duplication should always be considered in children presenting with urinary infection [27,28]. Of 47 children in our series with urological anomalies, 1 had renal duplication, 1 had ureteric duplication, and both of the duplications occuring with VUR. In Williams' series [29], the incidence of UTI with uretero–pelvic junction (UPJ) obsturction was 45.8% and was most common in children younger than 2 years of age. Of 6 children with UPJ obstruction, 3 were males and 3 were female in our study. Bauer et al [30] demonstrated that the most common presentation in children with bladder diverticula was UTI. One of our patients with bladder diverticula presented with UTI. Prenatal diagnosis may be of benefit to affected individuals in reducing the morbidity associated with UTI and renal scarring. Dilatation of the fetal urinary tract is being detected with increasing frequency on ultrasound imaging in pregnancy. This dilatation is most often caused by obstructive uropathy or VUR [31]. In our study, 3 (15.7%) of the 19 of patients less than one year with UTI had urological anomalies diagnosed by prenatal ultrasonography and confirmed after birth.

The organisms infecting the urinary tract in this study were *E.coli* (61.3%), *Proteus species* (23.6%),*Klebsiella pneumoniae* (8%), *Pseudomonas* (2.2%), *Staphylococcus* (1.7%) in their descending order of percentages. These results are similar to many latest published articles[32,33,34]. However, a few studies have indicated a lower percentage of *E.coli* infections and a higher infection with *Proteus* and *Klebsiella species*[35-38] On the other hand some have given a higher percentage of *E.coli* infection as compared to other organisms[39,40]. This could be explained on the basis of sampling technique and the gender difference in different studies. There is little dispute that *E. coli* is the most common pathogen found in children, In addition to its prevalence in this study, other studies have shown E. coli to be the most common infective organism[1]. In our study *E. coli* was the most common pathogen among children with or without urological anomalies. There were no differences in the microorganism patterns in patients with or without abnormalities($p<0.001$). Lomberg et al [41] suggest that the presence of VUR may predispose children to UTI with non–E. coli bacteria, and that non–E. coli infections are more common in children with anatomic or functional defects. In our study, E. coli was also the most common pathogen in patients with urological anomalies included VUR .Regarding these results we concluded that we must propose algorithm that includes non-invasive clinical and paraclinical Methods of investigation which we think it is optimal for prevention, early detection of urinary tract infection and the urological anomalies in children for establishment of the correct and early diagnosis. We were not surprised to find that the prevalence of urological anomalies were more common in study group, as many of our patients had histories of recurrent UTI. Proper investigations might have not been carried out at the time of their first episode of UTI. We believe that any child, male or female, in the first decade of life should have imaging studies with the first urinary tract infection. This is so important in the child under 5 years of age . these supports the idea that nearly all the patients with UTI need a complete imaging work up. We recommend that ultrasound and VCUG should be routinely performed on all patients after the first UTI. The diagnosis of UTI in young children is important as it is a marker for urinary tract abnormalities. A child with a suspected UTI should have a urine culture and colony count performed in order to identify organisms for confirmation of diagnosis and recommend prompt treatment to reduce UTI related morbidity and mortality in children.

References

1. Jodal U., and Hansson S.: Urinary tract infection. In: Pediatric Nephrology. Edited by Holliday, M.A., Barratt, T.M., and Anver, E.D., Baltimore: Villiams & Wilkins, 1994, pp. 950–62.
2. Ayse BALAT , L. Leighton HILL Genitourinary Abnormalities in Children with Urinary Tract Infections , Tr. J. of Medical Sciences 29 (1999) 59–63 .
3. Downs SM. Technical report: urinary tract infections in febrile infants and young children. The Urinary Tract Subcommittee of the American Academy of Pediatrics Committee on Quality Improvement. Pediatrics 1999;103:e54.
4. Shaw KN, Gorelick M, McGowan KL, Yakscoe NM, Schwartz JS. Prevalence of urinary tract infection in febrile young children in the emergency department. Pediatrics 1998;102:e16.
5. Dick PT, Feldman W. Routine diagnostic imaging for childhood urinary tract infections: a systematic overview. J Pediatr 1996; 128:15-22.
6. Gordon I, Barkovics M, Pindoria S, Cole TJ, Woolf AS. Primary vesicoureteric reflux as a predictor of renal damage in children hospitalized with urinary tract infection: a systematic review and meta-analysis. J Am Soc Nephrol 2003;14:739-44.
7. So LY, Davies DP. Urinary tract infection in childhood: a study of 137 cases. HK J Paediatr 1988;5:17-24.
8. Hoberman A, Charron M, Hickey RW, Baskin M, Kearney DH, Wald ER. Imaging studies after a first febrile urinary tract infection in young children. N Engl J Med 2003;348: 195-202.
9. Rushton HG. Urinary Tract Infections in Children. Pediatric Clinics of North America 1997; 44: 1133-1169 .
10. Travis LB, Brouhard BH. Infections of the urinary tract. In: Rudolph AM, ed. Rudolph's Pediatrics. 20th ed. Stanford, Conn.: Appleton & Lange, 1996:1388-92.
11. Tolkoff NE, Rubin RH. Urinary tract infection. Significance and management. Bulletin of the New York Academy of Medicine, 1986, 62(2):131-48.
12. Naylor GR. A 16-month analysis of urinary tract infection in children. Journal of medical microbiology, 1984, 17(1):31-6.
13. Warren JW. Catheter-associated urinary tract infections. Infectious disease clinics of North America, 1987, 1(4):823-54.
14. Chow CB, Yau FT, Leung NK. Symptomatic urinary tract infection in Hong Kong children. JHK Med Assoc 1988;40: 276-80.
15. Hoberman A, Charron M, Hickey RW, Baskin M, Kearney DH, Wald ER. Imaging studies after a first febrile urinary tract infection in young children. N Engl J Med 2003;348:195-202.
16. Kieley B., Rees JPR. Sex differences in urinary tract infection in children. Irish Med J 77: 384–7, 1984.

17. **Bahna SL., Torp KH., The sex variable in childhood urinary tract infection. Acta Paediatr Scand 64: 581–6, 1975.**
18. **Burbige KA., Retik AB., Colodny AH., Bauer SB., Lebowitz R.: Urinary tract infection in boys. J Urol 102: 541–2, 1984.**
19. **Shah KJ, Robins DG, White RH. Renal scarring and vesicouretesral reflux. Arch Dis Child 1978;53:210-7.**
20. **Sciagra R, Materassi M, Rossi V, Ienuso R, Danti A, La Cava Gl. Alternative approaches to the prognostic stratification of mild to moderate primary vesicoureteral reflux in children. J Urol 1996;155:2052–6.**
21. **Stokland E, Hellstrom M, Jacobsson B, Jodal U, Lindgren P, Sixt R. Early 99mTc mercaptosuccinic acid (DMSA) scintigraphy in symptomatic first-time urinary tract infection. Acta Paediat 1996;85:430–6.**
22. **Howard RG, Roebuck DJ, Yeung PA, Chan KW, Metreweli C. Vesicoureteric reflux and renal scarring in Chinese children. Br J Radio 2001;l74:331–4.**
23. **Ditchfield MR., De Campo JF., Nolan TM., et al. Risk factors in the development of early renal cortical defects in children with urinary tract infection. AJR 162: 1393–7, 1994.**
24. **Siegel SR., Siegel B., Sokoloff BZ., et al. Urinary infection in infants and preschool children. Am J Dis Child. 134: 369–72, 1980.**
25. **Shalaby-Rona E, Lowe LH, Blask AN, Majd M. Imaging. In: Pediatric Urology. Pediatric Clinical North America 1997;44:1065-86.**
26. **Ali Ahmadzadeh Association of urinary tract abnormalities in children with first urinary tract infection Pak J Med Sci January - March 2007 Vol. 23 No.1 88-91 .**
27. **Decter RM. Renal duplication and fusion anomalies. Pediatr Clin North Am 44: 1323–41, 1997.**
28. **Bisset GS., Strife J. The duplex collecting system in girls with urinary tract infection: Prevalence and Significance. AJR 148: 497–500, 1987.**
29. **Williams DI, Kenawi MM. The prognosis of pelviureteric obstruction in childhood: A review of 190 cases. Eur J Urol 2: 57–63, 1976.**
30. **Bauer SB., Retik AB. Bladder diverticula in infants and children. J Urol. 3: 712–5, 1974.**
31. **Gunn TR., Mora JD., Pease P. Antenatal diagnosis of urinary tract abnormalities by ultrasonography after 28 weeks' gestation: incidence and outcome. Am J Obstet Gynecol 172: 479–86, 1995.**
32. **Elder JS. Urinary tract infection. Behrman RE, Kliegman RM, Jenson HB, editors. Nelson Textbook of Pediatrics. 17th ed. Philadelphia: WB Saunders Company; 2004.p.1621-5.**

33. **Waisman Y, Zerem E, Amir L, Mimouni M. The Validity of the Uriscreen Test for Early Detection of Urinary Tract Infection in Children. Pediatrics 1999;104(4):p. e41.**
34. **Modarres S, Nassiri N. Bacterial etiologic agents of urinary tract infection in children in the Islamic Republic of Iran. East Mediterr Health J 1997;3(2):290-5.**
35. **Biyikli NK, Alpay H, Ozek E, Akman I, Bilgen H. Neonatal urinary tract infections: Analysis of the patients and recurrences. Pedtr Int 2004;46:21-5.**
36. **Arslan S, Caksen H, Rastgeldi L, Uner A, Oner AF, Odabas D. Use of urinary gram stain for the detection of urinary tract infection in childhood. Yale Journal of Biology and Medicine 2002;75:73-8.**
37. **Falcao MC, Leone CR, D'Andrea RA, Berardi R, Ono NA, Vaz FA. Urinary tract infections in full-term newborn infants: value of urine culture by bag specimen collection. Rev Hosp Clin Fac Med Sao Paulo1999;54: 91–6.**
38. **Acharya VN, Jadav SK. Urinary tract infection: current status. J Postgrad Med 1980;26:95-8.**
39. **Mehr SS, Powell CV, Curtis N. Cephalosporin resistant urinary tract infections in young children. J Paediatr Child Health 2004;40(1-2):48-52.**
40. **Saleh SI, Tuhmaz MM, Sarkhouh MY, El-Ghawabi MA. Urinary tract infection in children in Al-jahra area, Kuwait: An overview. Kuw Med J 2003;35(1):31-35.**
41. **Lomberg H., Hellstrom M., Jodal U., et al. Virulence–associated traits in Escherichia coli causing first and recurrent episodes of urinary tract infection in children with or without vesicoureteral reflux. J Infect Dis 150: 561–9, 1984.**