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Genitourinary Abnormalities in Children with Urinary Tract Infections

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Abstract: Urinary–tract infections (UTI) are common infectious diseases in childhood. The presence of UTI may be an indicator of a serious genitourinary (GU) abnormality that requires medical intervention. We retrospectively reviewed the charts of children discharged with a diagnosis of UTI from the Texas Children's Hospital, Houston, Texas, between July 1, 1991 and June 30, 1994. The purpose of the study was to determine how many patients had underlying GU abnormalities, the specific type of abnormality, and the microorganism causing the UTI. During the 3–year period, there were 48,382 discharges from the hospital, and 1,221 (2.5%) of those discharges were patients with UTI. Of the 1,221 cases of UTI, one hundred thirty–seven acquired the disease nosocomially and were not included this study leaving 1,084 with first–time or recurrent infections. Of the, 1,084 patients, 806 underwent radiologic evaluation, and 275 (34.1%) of 806 had underlying GU abnormalities. There were 167 girls and 108 boys ranging in age from 7 days to 18 years (mean age: 5.7 years). The percentage of abnormalities found in girls (35.4%) was similar to the percentage found in boys (32.8%). The distribution of abnormalities showed some changes by age and sex. Lower urinary–tract abnormalities were common in children older than 3 years of age (43.5% vs 20.5%, P<0.001). Vesico–ureteral reflux was common in children below 3 years of age (51.6% vs 25%, P<0.001). Lower urinary–tract abnormalities were higher in boys (41.7% vs 24%, P<0.001). Lower urinary–tract abnormalities were higher in boys (41.7% vs 24%, P<0.001), whereas the percentage of vesico–ureteral reflux was higher in girls (47.4% vs 27.3%, P<0.001). The distribution of upper urinary–tract abnormalities or combined abnormalities was similar for both sexes. Renal scarring was found more often in children with reflux than in children without reflux (14% vs 1.9%, P<0.05). The most common microorganism was *Escherichia coli*; the second common microorganism was *Pseudomonas*. There were no differences in the microorganism pattern in patients with and without GU abnormalities. Our finding that more than one–fourth of the UTI patients in our study group had a underlying GU abnormality is significant and provides support for early intervention to identify and treat these complications that could cause serious, irreparable kidney damage.

Key Words: Genitourinary abnormality, urinary tract infections.

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 genitourinary (GU) 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). The purpose of this study was to determine the frequency and types of GU abnormalities occuring in pediatric UTI patients and to determine the microorganisms causing UTI in these patients.

Patients and Methods

All patients discharged with the diagnosis of first–time or recurrent UTI from Texas Children's Hospital, Houston, Texas, between July 1, 1991 and June 30, 1994, were included in this study. Patients with

nosocomial UTI were excluded. UTIs 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 reviewed retrospectively, 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 GU abnormalities was extracted.

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 suprapubic aspirated urine specimen (1).

Statistical analysis:

Chi–square and Fisher–exact tests were used to compare the groups. P values less than 0.05 were considired significant.

Results

Patients

During the 3–year study period, 48,382 patients were discharged from Texas Children's Hospital, 1,221 (2.5%) of whom had a discharge diagnosis of UTI. Of these 1,221 patients, 1,084 had first–time or recurrent UTI, and 137 had nosocomial UTI. There were 447 boys and 637 girls.

Of 1,084 children with UTI, 827 were first–time occurrences, 257 were recurrences. Four hundred–sevently one (56.9%) of patients with first UTIs were girls, and 356 (43%) were boys; whereas, 166 (64.6%) of patients with recurrent UTIs were girls, and 91 (35.4%) were boys. Of the 1,084 UTIs, 275 (25.4%) had GU abnormalities: 167 were girls and 108 were boys. Patient age ranged from 7 days to 18 years (mean: 5.7 years).

One hundred any fifty–one of the 275 patients with GU abnormalities were younger than 3 years of age. Ninety–four patients were experiencing first–time UTIs, and the other 181 had experienced one or more previous UTIs. Fourty–eight (51%) of the patients with first–time UTIs were girls, and 46 (49%) were boys; whereas, 119 (65.7%) of the patients with recurrent UTIs were girls, and 62 (34.3%) were boys. There were 155 White patients, 33 Blacks, 84 Hispanics, and 3 of other races with GU abnormalities.

Genitourinary Abnormalities

Of 1.084 patients, 806 (75%) underwent radiological evaluation because of UTI. Of the 806 patients, 472 were girls, and 334 were boys. We could not find any information regarding the radiological evaluation of other 278 patients. All 806 patients had ultrasonographic examinations. In addition, 515 also had voiding cystourethrography (VCUG), 45 had renal nuclear scans, 12 had intravenous pyelography, and 2 had computed tomography scans.

Two hundred and seventy–five (%34.1) of these patients had abnormal GU findings. Of 334 boys, 108 (32.3%) had GU abnormalities. Of 472 girls, 167 (35.4%) had GU abnormalities. Because some of the patients had two or more abnormalities, we categorized the findings as upper–GU, lower–GU, combined abnormalities, and VUR without other abnormalities (Table 1).

Table 1. Associated genitourinary abnormalities in 275 children with UTI.

Upper tract anomalies (n=69)	No.
uretero–pelvic junction obstruction	21
duplication	21
renal agenesis/dysplasia/cystic kidney	17
hydronephrosis (caused ?)	6
ureterovesical junction obstruction	2
horseshoe kidney	1
ureteral stenosis	1
Lower tract anomalies (n=85)	
neurogenic bladder	39
bladder and/or cloacal exstrophy	22
urethral stenosis/atresia	11
posterior urethral valve	7
bladder diverticulum	4
urethrocele	1
urachal remnant	1
Combined Anomalies (n=9)	9
Vesicoureteral Reflux (n=112)	112

The distribution of abnormalities showed some changes by age and sex (Tables 2 and 3). Lower–GU abnormalities were common in children older than 3 years of age (43.5% vs 20.5%, P<0.001). Vesicoureteral reflux (VUR) was common in children younger than 3 years of age (51.6% vs 25%, P<0.001). Lower–GU

abnormalities were higher in boys (41.7% vs 24%, P<0.001), whereas VUR was higher in girls (47.4% vs 27.3%, P<0.001). The distribution of upper–GU abnormalities or combined anomalies was similar between the sexes. One hundred and twelve children had VUR as an only abnormality. VUR also occured in 18 children with upper–GU abnormalities, in 17 children with lower–GU abnormalities, and in 3 children with multiple abnormalities. Forty–five patients had nuclear scans because of the suspicion of renal scarring and thirty–nine of these were found to have renal scarring: 18 had VUR only, 10 had upper–GU abnormalities (one of which involved VUR), 5 had lower–GU abnormalities, and 4 had combined abnormalities (2 of which involved VUR). Two patients with recurrent UTI whose ultrasound and VCUG results were normal also had renal scarring. Twenty–three of the patients with demonstrated scarring were girls, and 16 were boys. Of the 39 patients with renal scarring, 21 (53.8%) were younger than 3 years of age. Fifteen (38.5%) of the 39 patients with renal scarring were younger than 1 year of age, and 9 (60%) of these 15 patients were experiencing first–time UTIs.

Table 2. Genitourinary abnormalities in different age groups.

	Age Group (year)			
	0–3		>3–18	
Genitourinary abnormalities	No	%	No	%
Upper	36	23.8	33	25.8
Lower*	31	20.5	54	43.5
Combined	4	2.6	5	3.9
VUR*	80	51.6	32	25
Total	151	100	124	100

* P<0.001

Five (6.3%) of the 80 newborns in the patient group had GU abnormalities diagnosed by prenatal ultrasonography and confirmed after birth. Two of these infants had VUR, 2 had obstruction of the ureteropelvic junction, and 1 had renal duplication and ureterocele.

Microbiology of the Patients with Demonstrated Anatomical Abnormalities

Of the 275 urine cultures taken, 201 were catheter specimens; 55 were midstream, clean–voided specimens; 10 were suprapubic aspirates; and 9 were nephrostomy specimens. A total of 310 organisms were isolated. Two hundred and sixty–two patients had infection derived from single organisms, 24 had infections derived from two organisms.

Table 3. Genitourinary abnormalities in girls, and boys.

	Sex			
	Girls		Boys	
Genitourinary abnormalities	No	%	No	%
Upper	43	25.7	26	23.6
Lower*	40	24	45	41.7
Combined	2	1.2	7	6.4
VUR*	82	47.4	30	27.3
Total	167	100	108	100

* P<0.001

Table 4. Microorganism pattern in patients with or without genitourinary tract abnormalities.

	Patients with GU abnormalities		Patients without GU abnormalities	
Microorganisms	No	%	No	%
E. Coli	165	53.2	512	57.6
Pseudomonas	33	10.6	60	6.8
Klebsiella	30	9.7	78	8.8
Enterobacter	17	5.5	17	1.9
Staphylococcus	15	4.8	40	4.5
Enterococcus	15	4.8	64	7.2
Proteus	12	3.9	45	5.1
Streptococcus	7	2.3	29	3.2
Candida	5	1.6	9	1
Citrobacter	5	1.6	17	1.9
Others**	6	1.9	17	1.9
Total	310	100	888	100

* P>0.05, ** others were Providencia Rettgeri, Serratia, M. Morganii, Acinetobacter, Shiegella, Diphteroid, Salmonella, Trichomonas, Chlamydia, Adenovirus, H. Influenza.

Colony counts were greater than 10^5 in 254 children, 10^4 in 34 children, and 10^3 in 22 children. There was no difference in the distrubition of microorganism in patients with and without GU anomalies (Table 4, P>0.05). *Escherichia coli* was the most common pathogen among all patients (those with GU abnormalities and those without). *Pseudomonas* was the second and *Klebsiella* as the third common pathogen in patients with abnormalities.

Discussion

UTI accounted for 2.5% of discharges at our institution during the period studied. More than one–fourth of the UTI patients had GU abnormalities although only 806 of the 1084 patients had imaging studies. The percentage of the GU abnormalities in boys and in girls was similar in our study. However, most of the studies in literature revealed high rates of GU abnormalities in boys than girls (2–4). Kieley et al (2) 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 (3), 50% of 8 boys and 43.3% of 116 girls with UTI had GU abnormalities. In the series by Burbige et al (4), the incidence of anatomical abnormalities was 75% in 83 boys presenting with first–time UTI.

Recurrent UTI is common in girls (5). Our results appear to be consistent with the literature.

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 (6, 7). It was more prevalent among girls than among boys. In our study, we found more renal scarring in girls than boys. In one study, renal scarring was reported in 4.5% of the girls with UTI and in approximately 13% of the boys (8). Previous studies have shown that renal scarring was almost always associated with VUR (9). In our study, renal scarring was found in 21 children with VUR and in 18 children without VUR. This result confirms the observations made by others that renal scarring is more common in the presence of VUR; however, it also suggests that we must be aware that scars may develop without VUR (10). Infants and children younger than 3 years old are at the greatest risk of developing renal scarring (11, 12). It has been demonstrated that some pediatric patients seen for their first UTI already have scarring (13).

In fact, in our study, 15 of 39 patients with renal scarring were younger than 1 year of age, and 60% of them were experiencing first–time infection when the scarring was detected. The neonatal period and first year of life appear to have special significance in the prognosis of UTI.

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 GU abnormality should always be considered in children presenting with UTI. Duplication of the upper GU 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 (14, 15). Of 21 children in our series with duplication, 19 had renal duplication, 2 had ureteric duplication, and 7 of the duplications occuring with VUR.

In Williams' series (16), 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. UPJ obstruction is reported to be more common in males and most frequently left–sided (17). Of 21 children with UPJ obstruction, 12 were males and 11 (52%) were left–sided in our study. Bauer et al (18) demonstrated that the most common presentation in children with bladder diverticula was UTI. All of our patients with bladder diverticula presented with UTI.

Prenatal diagnoses 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 (19). In our study, 5 (6.3%) of the 80 newborn patients with UTI had GU abnormalities diagnosed by prenatal ultrasonography and confirmed after birth.

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 GU abnormalities. There were no differences in the microorganism patterns in patients with or without abnormalities. Lomberg et al (20) 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 VUR.

Conclusions

From our experience, as many as 34.1% of children admitted to the hospital with first–time or recurrent UTIs are found to have GU abnormalities. *E. coli* remains the most causative pathogen for patients with and without GU abnormalities. 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 most important in the child under 3 years of age to prevent renal damage.

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