CHAPTER 13

Urinary Tract Infection in Children

Andrew L. Freedman, MD
Director of Pediatric Urology
Minimally Invasive Urology Institute
Cedars-Sinai Medical Center
Los Angeles, California

Contents

Urinary Tract Infection in Children

Andrew L. Freedman, MD

INTRODUCTION

Urinary tract infection (UTI) affects 2.6% to 3.4% of children in the United States annually. Throughout childhood, the risk of UTI is 2% for boys and 8% for girls. UTIs are primarily managed in physicians' offices, where they account for more than 1 million visits (0.7% of all pediatric office visits) per year. The emergency room is also an important site of care, accounting for 5% to 14% of physician encounters for pediatric UTI. Inpatient hospitalization is required in 2% to 3% of cases, with UTI accounting for more than 36,000 admissions in 2000. More care is rendered to girls than to boys, at a ratio of 3–4 to 1. Hospitalization is more frequent for infants, but it is more expensive for adolescents. Overall costs for inpatient hospital care increased during the 1990s despite shorter lengths of stay. The cost of hospitalization for UTI amounts to more than $180 million annually. However, the true financial burden is probably much higher because it includes costs for outpatient services, imaging, other diagnostic evaluations, long-term complications, and management of associated conditions that increase the frequency and morbidity of UTI. The economic impact on the family due to parental work loss is largely unknown. Efforts to lessen the economic burden on patients, payers, and society include decreasing the length and frequency of inpatient hospitalizations, streamlining the post-UTI imaging evaluation, developing new antimicrobials to fight resistant organisms, and generating easy-to-implement nonantimicrobial strategies.

DEFINITION AND DIAGNOSIS

Normally, the urinary tract proximal to the distal urethra is sterile, but it is constantly challenged by infectious pathogens fighting to gain access. A UTI, strictly speaking, occurs when an infectious agent is present within this sterile system; however, a more appropriate clinical definition is that UTI occurs when the infectious agent is not only present, but is also causing illness. This distinction underscores the inherent clinical difficulty of managing patients with UTI. In practice, a diagnosis of UTI is presumed when irritative urinary tract symptoms occur simultaneously with a positive test for infectious agents, such as bacteria, fungi, viruses, or parasites, in the urinary tract. Because other factors can cause similar symptoms, the presence of symptoms in the absence of a positive culture has historically been considered inadequate for diagnosis. Likewise, the presence of leukocytes in the urine is not proof of infection. Asymptomatic bacteriuria may represent colonization or contamination and should be differentiated from UTI. Thus, for clinical purposes, the definition of a UTI requires a combination of symptoms and laboratory findings.

Both the infectious agent and the anatomic location typically define the UTI. The urinary tract is commonly divided into the upper tract (kidneys and ureters) and the lower tract (bladder and urethra). In the male, infections such as prostatitis, epididymitis, and orchitis are frequently included as UTIs but are more accurately considered genital infections; they have a separate epidemiology and natural history.

Table 1. ICD-9 codes used in the diagnosis and management of pediatric urinary tract infection

Individuals under 18 with any one of the following ICD-9 codes:	
Cystitis	
112.2	Candidiasis of other urogenital sites
120.9	Schistosomiasis, unspecified
595.9	Cystitis, unspecified
595.1	Chronic interstitial cystitis
595.0	Acute cystitis
595.3	Trigonitis
595.89	Other specified types of cystitis
595.2	Other chronic cystitis
Pyelonephritis	
590.0	Chronic pyelonephritis
590.00	Chronic pyelonephritis without lesion of renal medullary necrosis
590.01	Chronic pyelonephritis with lesion of renal medullary necrosis
590.1	Acute pyelonephritis
590.10	Acute pyelonephritis without lesion of renal medullary necrosis
590.11	Acute pyelonephritis with lesion of renal medullary necrosis
590.2	Renal and perinephric abscess
590.3	Pyeloureteritis cystica
590.8	Other pyelonephritis or pyonephrosis, not specified as acute or chronic
590.9	Infection of kidney, unspecified
593.89	Other specified disorders of kidney and ureter
Orchitis	
016.5	Tuberculosis of other male genital organs
072.0	Mumps orchitis
603.1	Infected hydrocele
604.0	Orchitis epididymitis and epididymo-orchitis with abscess
604.9	Other orchitis, epididymitis, and epididymo-orchitis, without mention of abscess
604.90	Orchitis and epididymitis, unspecified
604.99	Other orchitis epididymitis and epididymo-orchitis without abscess
608.0	Seminal vesiculitis
608.4	Other inflammatory disorders of male genital organs
Other	
597.89	Other urethritis
599.0	Urinary tract infection, site not specified
607.1	Balanoposthitis
607.2	Other inflammatory disorders of penis
646.5	Asymptomatic bacteriuria in pregnancy

In this chapter, genital infections are excluded from the definition of UTI, and non-sexually transmitted orchitis is discussed separately.

UTIs are also categorized as complicated or uncomplicated. Complicated UTIs are infections in which there is a comorbidity that predisposes a child either to infection or to greater morbidity due to the infection. Comorbidities include the presence of stones, neurological impairment affecting urinary tract functioning, and anatomic abnormalities such as obstruction, reflux, or enterovesical fistula.

UTI is a frequent complication of medical care, especially hospitalization. Unfortunately, the datasets analyzed for this chapter preclude distinguishing nosocomial from community-acquired infections.

In this compendium, children are defined as persons less than 18 years of age. Where possible, they are further subdivided into infants (under 3 years of age), older children (3 to 10), and adolescents (11 to 17). Most of the datasets analyzed for this chapter do not distinguish the site of the UTI, with the notable exception of data from the Healthcare Cost and Utilization Project (HCUP) and MarketScan, in which pyelonephritis and orchitis, respectively, are distinguished from UTIs in other sites. The method by which the site of UTI is determined in these datasets is based on diagnostic coding and likely varies across the population.

The vast majority of UTIs are caused by bacterial agents, the most important of which are the Enterobacteriaciae, a family of gram-negative bacilli. *Escherichia coli* accounts for more than 80% of acute UTIs in children. The rest of the cases are distributed primarily among *Proteus mirabilis*, *Klebsiella pneumonia*, and *Pseudomonsa aeruginosa*. Less common infectious agents include gram-positive cocci, such as *Enterococcus* and *Staphylococcus*. Fungal infections, particularly *Candida*, are usually seen in nosocomial infections, complicated UTIs, or catheter-associated UTIs. Viral infections are under-recognized because of difficulties with culture and identification, but they have clearly been associated with infectious bladder symptoms. Cytomegalovirus is frequently seen in immunocompromised patients, particularly following organ transplantation.

Analyses for this chapter are based on the ICD-9 codes defining UTI listed in Table 1.

The clinical diagnosis of UTI is usually based on a combination of symptoms, physical and radiographic findings, and laboratory results. Diagnostic methods vary markedly and depend on presentation, clinical suspicion, medical history, and local practice patterns. Children pose a unique challenge in the diagnosis of UTI, because they often are unable to provide an accurate history or description of symptoms. Obtaining adequate specimens may also be difficult, and clinical signs such as fever and leukocytosis may be unreliable in the very young.

A lower tract infection is typically suspected in the presence of dysuria, urgency, frequency, and, less commonly, suprapubic pain. Upper tract involvement is typically heralded by fever, flank pain, nausea, vomiting, and lethargy. In the young child, there can be significant overlap in the clinical presentations of upper and lower tract infections. Symptoms may not be verbalized, and the diaper may conceal the voiding pattern. Fever is frequently the presenting sign, although lethargy may be the sole indicator of significant infection in infants. Parents' perception of an odor is an unreliable sign of infection (1). Hence, the clinician must have a high index of suspicion to make an accurate diagnosis of UTI.

Diagnosis is further hindered by the difficulty of obtaining adequate samples for laboratory testing. Urinalysis, the standard initial screening test for UTI, ideally requires a midstream, clean catch of urine, but this may be impossible in the very young. Alternatively, urine can be obtained by sterile catheterization or suprapubic needle aspiration. However, both of these techniques are invasive and frequently met with parental disapproval. Urine may be obtained by the adherence of a sterile collection bag to the perineum, but this method has a high rate of contamination, limiting its reliability. Once obtained, urine is examined with a reagent dipstick for the presence of nitrates and leukocyte esterase. A finding that the urine is crystal clear to visual inspection has a 97% negative predictive value for UTI (2). The urine can also be microscopically examined after gram-stain, as well as cultured for the presence of bacteria or fungi. Other adjunctive laboratory tests include serum white blood cell count and C-reactive protein level (3).

Imaging studies can assist in diagnosis, but they play a more prominent role in elucidating underlying comorbid conditions that may increase the risk or morbidity of infection. Ultrasound, the most common imaging study employed in cases of pediatric UTI, is used to evaluate for the presence of obstruction or stones, which can greatly increase the severity and sequelae of infection. The ultrasonographic appearance of the kidney can also be altered by the presence of acute infection. Ultrasound can assist in localizing the site of infection in the presence of renal abscess, parenchymal edema (lobar nephronia), or pyonephrosis. Despite the many advantages of ultrasound (it has no ionizing radiation and is non-invasive, well-tolerated, relatively low-cost, and readily available), its usefulness for identifying acute UTI has recently been questioned, given its relatively low yield in an era of widespread prenatal screening (4). Indeed, significant controversy has arisen over the timing of imaging studies and their implications for therapy recommendations in children with UTIs (4).

The nuclear renal scan with dimercaptosuccinic acid (DMSA) has been proposed as the most sensitive means for documenting renal involvement in UTI (5). It has been reported to be the best method for confirming acute pyelonephritis and later for assessing the presence of scarring. Many advocate basing further evaluation and follow-up care on the results of the DMSA scan (6). Computed tomography (CT) can also be useful for identifying anatomic anomalies, stones, and intrarenal abscess, as well as for documenting renal involvement in UTIs. CT is often used to exclude alternate diagnoses, such as appendicitis, in the presence of fever and abdominal pain or hematuria. Intravenous pyelography (IVP) is rarely used in the evaluation of pediatric UTI, particularly in young children, in whom renal visualization is limited by poor renal concentrating ability and increased small bowel air. Voiding cystourethrography (VCUG) has no role in the diagnosis of acute UTI, although it is nearly universally recommended for identifying vesicoureteral reflux or other anatomic abnormalities that may contribute to future infection risk.

NATURAL HISTORY

The natural history of uncomplicated acute cystitis is generally benign and free of significant long-term morbidity. The course is typically characterized by discomfort and irritative voiding symptoms with rapid resolution following the initiation of appropriate antimicrobials. The primary risk is that of recurrence or persistence. Children with constipation or voiding dysfunction are particularly prone to recurrence; 10% of these children develop a rapid recurrence following the completion of a course of antimicrobials. However, most recurrences do not progress to severe infections in the absence of anatomic abnormalities, and recurrent childhood UTIs tend to disappear in adolescence.

The natural history of pyelonephritis carries greater potential for long-term morbidity. Pyelonephritis can result in irreversible scarring of the renal parenchyma due to interstitial inflammation and virulence factors from the pathogen. Renal scarring is frequently, although not exclusively, associated with the simultaneous presence of reflux and infection. The likelihood of scarring increases with the number of infectious episodes, but significant renal damage can occur after a single infection. Renal scarring can lead to renal insufficiency and subsequent hypertension. The actual incidence of renal insufficiency due to scarring is unknown, in part because of changing definitions of reflux nephropathy and changing clinical presentations that have resulted from the widespread use of prenatal ultrasound. Historically, reflux nephropathy was considered responsible for 3% to 25% of the ESRD cases in children (7).

RISK FACTORS

The urinary tract is challenged by the ubiquitous presence of pathogens in close proximity. Any factors that enhance bacterial virulence or detract from host defense can predispose to UTI. Bacterial virulence factors include adhesins, K-antigen, hemosysins, and colicin. Bacterial colonization of the perineum typically precedes acute infection in the susceptible host. Adhesins are specialized structures that enable the bacteria to adhere to specific receptors on the uroepithelium. Such attachment leads to ascension into the urinary tract and promotes tissue invasion, inflammation, and tissue injury. Adhesins may also help promote intestinal carriage of more virulent bacteria, leading to perineal colonization. K-antigen helps prevent phagocytosis of bacteria; hemosysins damage renal tubular cells; and colocin helps kill competing bacteria near the colocin-producing cell.

Successful host defense depends on the proper functioning of the urinary system. A primary function of the urinary tract is the frequent and complete emptying of urine in a low-pressure environment. This effectively flushes out bacteria prior to their establishment of clinical infection. Any breakdown in this process can tip the balance toward the pathogen and result in UTI. Host risk factors are thought to include vesicoureteral reflux, dysfunctional voiding, constipation, obstruction, and gender-specific anatomy (the short urethra in females and the prepuce in males).

Vesicoureteral reflux is a frequent finding in children presenting with febrile infections. Present in approximately 1% of the asymptomatic population and 35% of those with UTI, reflux increases the risk of infection, in part by increasing post-void residual. Reflux also bypasses one of the host defense mechanisms against upper tract invasion by allowing less virulent strains of bacteria to reach the kidney.

Obstruction at the ureteropelvic junction, ureterovesical junction, or urethra is an infrequent but important host risk factor that can contribute to increased morbidity, persistence, and recurrence. Obstruction is present in fewer than 1% of children with UTI.

Dysfunctional voiding and dysfunctional elimination (constipation or functional fecal retention) are increasingly recognized as important host risk factors for UTI, particularly recurrent infections in anatomically normal children. Dysfunctional voiding refers to a learned pattern of behavior surrounding voiding that frequently begins with voluntary holding. It can present clinically with irritative symptoms such as urgency, frequency, urge incontinence, pelvic pain, and signs of holding such as squatting. Alternatively, it can present as an atonic bladder with infrequent voiding and high post-void residuals. In both patterns, elevated intravesical pressure, infrequent voiding, and poor emptying enhance the risk of UTI. Frequently, dysfunctional voiding can be compounded by chronic constipation. The exact mechanism by which constipation exerts its influence on voiding is unclear, but it frequently coexists in children with recurrent UTIs, and its resolution is often associated with resolution of the UTIs.

The relatively short length of the female urethra has traditionally been blamed for the increased risk of UTIs in girls. In the past, there was concern that a tight ring narrowed the urethra, often prompting urethral dilation in girls with UTI. Current evidence indicates that urethral constriction is not a reproducible finding, nor does it cause infection. Urethral dilation should play no role in the contemporary management of UTI in girls.

In boys, the most widely discussed host risk factor for UTI is the presence of the prepuce. It is clear that male infants with an intact prepuce are at a significantly higher risk of UTI during their first year of life. Colonization of bacteria on the inner preputial mucosa occurs, but it is not clear whether this is the etiology of infection (8). Circumcision is protective against UTI, but it carries its own risks. Uncircumcised boys have an overall 12-fold increased risk of urinary infection during their first 6 months compared with circumcised boys, in addition to a significantly higher probability of hospital admission for UTI (7.02 of 1,000) as compared with circumcised boys (1.88 of 1,000; $P<0.0001$) (9). A fuller discussion of this controversial subject is beyond the scope of this chapter.

INCIDENCE

It is difficult to estimate accurately the incidence of UTI in the pediatric population. Contributing questions include whether the determination of infection is based on symptoms, positive culture, or both; how accurate the method of specimen collection is; how accurate the history is, especially in young children; whether evaluation is focused on a specific age group or gender; whether the data are prospective or retrospective; whether or not the infections are associated with fever; and what the baseline rate of circumcision is in the population.

Frequently quoted estimates place the incidence of UTI in infants at approximately 1% during the first year of life (boys and girls), cumulative incidence at approximately 2% at two years of life (boys and girls), and cumulative childhood risk at 2% for boys and 8% for girls (10). Beyond the age of 2, UTIs in boys are not common enough to alter the childhood incidence through age 17.

Boys are at the greatest risk for UTI in the first months of life, but the risk decreases significantly after age 2. Boys who are uncircumcised have a tenfold higher risk of UTI in the first year of life than do circumcised boys (11, 12).

Girls have an increased risk of febrile infection in the first year of life, then the risk steadily declines throughout childhood. Their risk of nonfebrile infections is higher during childhood than during infancy.

TRENDS IN HEALTHCARE RESOURCE UTILIZATION

Inpatient Care

Data from the Healthcare Cost and Utilization Project (HCUP) reveal that annual inpatient hospitalizations for UTI decreased slightly between 1994 and 2000, from 41,204 (60 per 100,000 children) to 36,568 (51 per 100,000 children) (Table 2). This declining trend was noted in both genders but was inconsistent across racial/ethnic groups and geographic regions. In 2000, hospitalization rates for UTI in infants (174 per 100,000) were substantially higher than those for older children (29 per 100,000) or adolescents (24 per 100,000). During the mid to late 1990s, girls were about 2.5 times more likely than boys to be hospitalized for UTI. Although not age-adjusted, the data from HCUP suggest that Hispanics were at much greater risk for UTI-related hospitalization than other racial/ethnic groups and that African Americans were at greater risk than Caucasians.

HCUP data also indicate that between 1994 and 2000, annual inpatient hospitalizations associated with pyelonephritis as a primary diagnosis remained stable at about 13,000 per year (18 to 20 per 100,000) (Table 3). Despite recent support for outpatient treatment of pediatric pyelonephritis (13), these data indicate no trend downward in hospitalization rates for this condition. From 1996 onward, the hospitalization rate was at least 2.5 times higher for infants than it was for older children or adolescents. The female-to-male ratio was at least 5:1 for each year analyzed. Racial/ethnic stratification suggested that African American children had a trend toward somewhat lower hospitalization rates for pyelonephritis, and that rates for Asian children were even lower. While the gender differences are consistent with clinical experience, the reasons for the racial/ethnic differences are not apparent. Hospitalization rates did not appear to vary by geographical region, but urban teaching hospitals had higher rates than did rural hospitals.

Age differences were most prominent among patients requiring hospitalization. The rate of inpatient hospital stays was 6.4 times higher among commercially insured infants than the rate among older children, and 11 times higher than the rate among adolescents (Table 4). This reflects the fact that UTIs in young children are more likely to involve the upper tract or to be complicated by comorbidities such as anatomic abnormalities. It also reflects more aggressive treatment patterns in the very young that tend to include parental antimicrobials.

Outpatient Care

Tables 4 and 5 present data from the Center for Health Care Policy and Evaluation (CHCPE) on visits by children insured commercially or through Medicaid for whom UTI was listed as the primary diagnosis. In both groups, the most common site of care for UTI was physicians' offices. Overall rates of visits to physicians' offices for UTI remained stable throughout the 1990s at approximately 2,400 per 100,000 (2.4%) for children with commercial insurance (Table 4) and 2,800 per 100,000 (2.8%) for children with Medicaid (Table 5). Among other settings—all much less commonly used than physicians' offices—emergency room (ER) visits were three times more common than inpatient hospitalizations. Of all encounters for which UTI was listed as the primary diagnosis, the rates of ER visits were substantially higher for those insured by Medicaid (Table 5) than the rates for those insured commercially (Table 4). Hospital outpatient clinics and ambulatory surgical centers contributed minimally, especially in the Medicaid population. Children with Medicaid visited physicians' offices, ERs, and ambulatory surgery centers more often than did children with commercial insurance.

That children with Medicaid visited emergency rooms for UTI-related care 2.8 times more frequently in 2000 than did those with commercial insurance (422 per 100,000 vs 150 per 100,000) is consistent with well-known patterns of care in socioeconomically disadvantaged populations. The slight decrease in the use of ERs by those insured through Medicaid from 1994 to 2000 may reflect improved access to primary care physicians or increasing dissatisfaction with the availability of ER care.

Table 2. Inpatient hospital stays by children with urinary tract infection listed as primary diagnosis, count, rate[a] (95% CI)

	1994		1996		1998		2000	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate
Total[b]	41,204	60 (54–67)	40,378	57 (51–63)	39,822	56 (50–61)	36,568	51 (46–55)
Age								
0–2	21,128	177 (150–203)	22,797	191 (163–219)	22,591	194 (166–222)	20,372	174 (153–195)
3–10	11,629	38 (34–41)	10,185	32 (28–35)	9,987	31 (27–34)	9,323	29 (26–31)
11–17	8,447	33 (30–36)	7,396	27 (25–30)	7,245	26 (24–28)	6,874	24 (23–26)
Gender								
Male	12,516	36 (30–42)	12,341	34 (28–40)	11,317	31 (26–36)	10,258	28 (24–31)
Female	28,678	86 (79–94)	28,037	81 (73–89)	28,501	81 (75–88)	26,306	75 (68–81)
Race/ethnicity								
White	18,579	41 (38–44)	17,276	38 (34–41)	16,339	36 (33–39)	14,504	32 (28–35)
Black	5,954	55 (48–62)	5,601	50 (43–57)	4,373	39 (33–46)	3,364	30 (25–36)
Asian/Pacific Islander	549	28 (20–37)	411	14 (8–20)	900	29 (20–39)	851	28 (19–38)
Hispanic	6,872	74 (50–97)	8,452	82 (56–107)	7,159	66 (45–86)	8,032	69 (58–80)
Region								
Midwest	8,394	51 (45–56)	7,393	44 (37–51)	7,443	44 (39–48)	7,666	44 (37–51)
Northeast	7,553	59 (49–68)	7,600	58 (48–67)	8,231	64 (51–76)	6,044	46 (39–54)
South	17,204	75 (61–90)	16,756	69 (57–80)	16,453	66 (55–77)	15,036	61 (52–71)
West	8,053	50 (38–63)	8,630	52 (34–69)	7,695	45 (35–56)	7,822	45 (37–53)
MSA								
Rural	7,946	46 (41–52)	7,738	48 (42–53)	6,780	41 (38–45)	6,938	44 (40–48)
Urban	33,114	65 (57–73)	32,595	59 (51–67)	32,794	59 (53–66)	29,594	52 (47–58)
Hospital type								
Rural	7,946	12 (10–13)	7,738	11 (10–12)	6,780	9 (9–10)	6,938	10 (9–10)
Urban non-teaching	16,230	24 (21–27)	16,764	24 (20–27)	10,929	15 (13–17)	11,435	16 (14–18)
Urban teaching	16,885	25 (20–30)	15,831	22 (17–27)	21,865	31 (26–35)	18,159	25 (21–29)

MSA, metropolitan statistical area.

[a]Rate per 100,000 based on 1994, 1996, 1998, 2000 population estimates from Current Population Survey (CPS), CPS Utilities, Unicon Research Corporation, for relevant demographic categories of US civilian non-institutionalized population under age 18.

[b]Persons of missing gender, other races, missing or unavailable race and ethnicity, missing MSA, and missing hospital type are included in the totals.

NOTE: Counts may not sum to totals due to rounding.

SOURCE: Healthcare Cost and Utilization Project Nationwide Inpatient Sample, 1994, 1996, 1998, 2000.

Table 3. Inpatient hospital stays by children with pyelonephritis listed as primary diagnosis, count, rate[a] (95% CI)

	1994		1996		1998		2000	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate
Total[b]	13,334	20 (18–21)	13,536	19 (17–21)	13,226	18 (17–20)	12,926	18 (16–20)
Age								
0–2	3,372	28 (23–33)	4,537	38 (31–45)	4,206	36 (29–43)	4,466	38 (32–45)
3–10	5,268	17 (15–19)	4,818	15 (13–17)	4,728	15 (12–17)	4,450	14 (12–15)
11–17	4,695	18 (17–20)	4,181	15 (14–17)	4,292	16 (14–17)	4,010	14 (13–16)
Gender								
Male	2,229	6.4 (5.3–7.4)	2,200	6.0 (4.7–7.4)	2,024	5.5 (4.5–6.6)	2,206	6.0 (4.9–7.0)
Female	11,099	33 (30–36)	11,336	33 (30–36)	11,201	32 (29–35)	10,720	30 (27–33)
Race/ethnicity								
White	7,150	16 (14–17)	6,869	15 (13–16)	6,647	14 (13–16)	5,934	13 (11–15)
Black	1,398	13 (11–15)	1,297	12 (10–14)	928	8.3 (6.5–10.1)	940	8.4 (6.2–10.6)
Asian/Pacific Islander	178	9.2 (5.2–13)	*	*	185	6.0 (3.2–8.8)	171	5.7 (3.2–8.2)
Hispanic	1,390	15 (12–18)	2,170	21 (15–27)	1,443	13 (9–17)	1,942	17 (13–20)
Region								
Midwest	3,032	18 (16–21)	3,036	18 (15–21)	3,066	18 (15–21)	3,263	19 (15–22)
Northeast	2,422	19 (14–23)	2,476	19 (15–22)	2,227	17 (14–20)	1,881	14 (12–17)
South	5,019	22 (19–25)	4,630	19 (16–22)	4,860	20 (17–23)	4,701	19 (15–23)
West	2,861	18 (14–21)	3,394	20 (14–27)	3,073	18 (13–23)	3,080	18 (14–22)
MSA								
Rural	3,314	19 (16–22)	2,903	18 (16–20)	3,104	19 (17–21)	2,846	18 (16–21)
Urban	9,964	20 (17–22)	10,589	19 (17–22)	10,025	18 (16–20)	10,067	18 (16–20)
Hospital type								
Rural	3,314	4.9 (4.1–5.6)	2,903	4.1 (3.6–4.6)	3,104	4.3 (3.8–4.9)	2,846	3.9 (3.4–4.5)
Urban nonteaching	5,450	8.0 (7.1–8.8)	5,552	7.8 (6.8–8.8)	3,933	5.5 (4.8–6.2)	4,169	5.8 (5.0–6.6)
Urban teaching	4,514	6.6 (5.3–8.0)	5,037	7.1 (5.5–8.6)	6,092	8.5 (6.8–10.2)	5,898	8.2 (6.6–9.7)

*Figure does not meet standard of reliability or precision.

MSA, metropolitan statistical area.

[a]Rate per 100,000 based on 1994, 1996, 1998, 2000 population estimates from Current Population Survey (CPS), CPS Utilities, Unicon Research Corporation, for relevant demographic categories of US civilian non-institutionalized population under age 18.

[b]Persons of other races, missing or unavailable race and ethnicity, missing MSA, and missing hospital type are included in the totals.

NOTE: Counts may not sum to totals due to rounding.

SOURCE: Healthcare Cost and Utilization Project Nationwide Inpatient Sample, 1994, 1996, 1998, 2000.

Table 4. Visits for urinary tract infections listed as primary diagnosis among children having commerical health insurance, count[a], rate[b]

	1994		1996		1998		2000	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate
	Physician Office Visits							
Total	7,600	2,395	10,801	2,382	16,206	2,425	17,101	2,374
Age								
<3	1,234	3,033	1,802	3,078	3,001	3,383	3,033	3,181
3–10	4,105	2,816	5,923	2,841	9,059	2,950	9,338	2,864
11–17	2,261	1,727	3,076	1,651	4,146	1,522	4,730	1,582
Gender								
Male	1,474	906	2,057	887	2,988	872	3,087	835
Female	6,126	3,961	8,744	3,950	13,218	4,059	14,014	3,997
	Emergency Room Visits							
Total	431	136	575	127	958	143	1,079	150
Age								
<3	81	199	97	166	197	222	183	192
3–10	185	127	271	130	422	137	459	141
11–17	165	126	207	111	339	124	437	146
Gender								
Male	85	52	132	57	176	51	218	59
Female	346	224	443	200	782	240	861	246
	Inpatient Visits							
Total	147	46	206	45	370	55	367	51
Age								
<3	68	167	104	178	178	201	202	212
3–10	54	37	67	32	115	37	108	33
11–17	25	*	35	19	77	28	57	19
Gender								
Male	32	20	41	18	56	16	88	24
Female	115	74	165	75	314	96	279	80
	Hospital Outpatient Visits							
Total	27	*	75	17	185	28	153	21
Age								
<3	2	*	16	*	58	65	40	42
3–10	16	*	48	23	94	31	79	24
11–17	9	*	11	*	33	12	34	11
Gender								
Male	3	*	14	*	28	*	28	*
Female	24	*	61	28	157	48	125	36
	Ambulatory Surgery Visits							
Total	49	15	63	14	211	32	139	19
Age								
<3	6	*	13	*	70	79	49	51
3–10	31	21	40	19	105	34	69	21
11–17	12	*	10	*	36	13	21	*
Gender								
Male	19	*	16	*	44	13	32	8.7
Female	30	19	47	21	167	51	107	31

*Figure does not meet standard for reliability or precision.

[a]Counts less than 30 should be interpreted with caution.

[b]Rate per 100,000 based on member months of enrollment in calendar year for children in the same demographic stratum.

SOURCE: Center for Health Care Policy and Evaluation, 1994, 1996, 1998, 2000.

Table 5. Visits for urinary tract infections listed as primary diagnosis among children having Medicaid, count[a], rate[b]

	1994		1996		1998		2000	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate
	Physician Office Visits							
Total	910	2,842	1,428	2,420	1,096	2,893	1,309	2,806
Age								
<3	193	2,427	350	2,569	312	3,551	335	3,232
3–10	554	3,035	838	2,576	572	2,955	733	3,147
11–17	163	2,804	240	1,868	212	2,177	241	1,855
Gender								
Male	214	1,334	337	1,140	271	1,424	305	1,304
Female	696	4,355	1,091	3,704	825	4,378	1,004	4,318
	Emergency Room Visits							
Total	193	603	303	514	155	409	197	422
Age								
<3	52	654	93	683	56	637	80	772
3–10	95	520	125	384	65	336	75	322
11–17	46	791	85	662	34	349	42	323
Gender								
Male	40	249	68	230	33	173	59	252
Female	153	957	235	798	122	647	138	594
	Inpatient Stays							
Total	36	112	59	100	43	114	44	94
Age								
<3	22	*	39	286	31	353	32	309
3–10	12	*	16	*	11	*	7	*
11–17	2	*	4	*	1	*	5	*
Gender								
Male	10	*	17	*	14	*	14	*
Female	26	*	42	143	29	*	30	129
	Hospital Outpatient Visits							
Total	7	*	23	*	13	*	7	*
Age								
<3	1	*	10	*	2	*	6	*
3–10	4	*	11	*	9	*	0	0
11–17	2	*	2	*	2	*	1	*
Gender								
Male	4	*	5	*	2	*	0	0
Female	3	*	18	*	11	*	7	*
	Ambulatory Surgery Visits							
Total	4	*	3	*	59	156	31	66
Age								
<3	0	0	1	*	31	353	15	*
3–10	4	*	1	*	26	*	16	*
11–17	0	0	1	*	2	*	0	0
Gender								
Male	2	*	2	*	15	*	7	*
Female	2	*	1	*	44	233	24	*

*Figure does not meet standard for reliability or precision.
[a]Counts less than 30 should be interpreted with caution.
[b]Rate per 100,000 based on member months of enrollment in calendar year for children in the same demographic stratum.
SOURCE: Center for Health Care Policy and Evaluation, 1994, 1996, 1998, 2000.

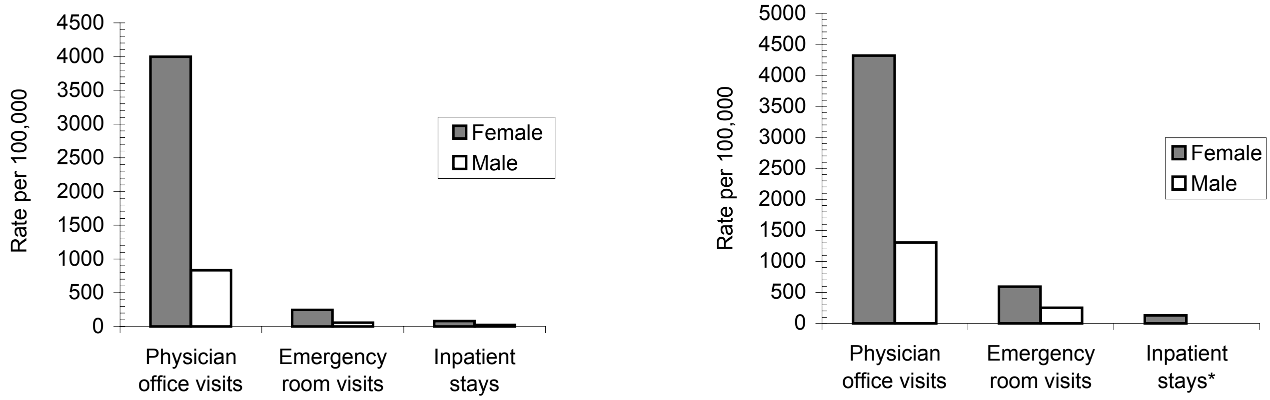

Figure 1. Urinary tract infections listed as primary diagnosis among children having commercial health insurance (left) and Medicaid (right) by visit setting and gender.

***The rate for males in this category was too low to produce a reliable national estimate.**

SOURCE: Center for Health Care Policy and Evaluation, 2000.

As expected, girls had much higher visit rates than boys did (Tables 4 and 5, Figure 1). The female-to-male ratio for physicians' office visits by commercially insured children rose from 4.4:1 in 1994 to 4.8:1 in 2000 (Table 4), but it remained stable at about 3.3:1 for children insured through Medicaid during the same time period (Table 5). The differences in these ratios are difficult to explain, but they may be due in part to the fact that boys covered by Medicaid are less likely to be circumcised. Caucasians are considerably more likely to be circumcised than are African Americans or Hispanics (81% vs 65% or 54%); these differences remain significant when other variables are controlled (14). Circumcision is not a covered service, and families insured through Medicaid may not be able to afford to pay for it out-of-pocket; the cost of circumcision typically ranges from $250 to $750. Families insured through Medicaid may also be more likely to have social norms that do not include routine circumcision. In the office setting, adolescents had lower visit rates than did either infants or older children, regardless of insurance status (Tables 4 and 5).

Data from the National Ambulatory Medical Care Survey showed that during 1992, 1994, 1996, 1998, and 2000, there were there were more than 1.1 million annual physician office visits (1,590 per 100,000 in each year) associated with UTI as the primary diagnosis and 1.4 million annual physician office visits (2,051 per 100,000 in each year) associated with UTI as any listed diagnosis (Table 6). Because counts were low for this diagnosis in children, these counts and rates were derived by first collapsing data from the even years in 1992–2000 and then dividing by 5. As a primary diagnosis, UTI accounted for 0.7 % of all physician office visits by children during those years. Data from the National Hospital Ambulatory Medical Care Survey showed that during 1994, 1996, 1998, and 2000, approximately 94,000 annual hospital outpatient visits (132 per 100,000 in each year) were associated with UTI as a primary diagnosis, representing 0.5% of all hospital outpatient visits by children (Table 7). Because counts were low for this diagnosis in children, these counts and rates were derived by first collapsing data from the even years in 1994–2000 and then dividing by 4.

NON-SEXUALLY TRANSMITTED ORCHITIS

Isolated orchitis is extremely rare in the prepubertal male and in most cases is due to the extension of acute epididymitis into epididymo-orchitis. Most cases occur in adolescents and present with fever, pain, testicular swelling, and scrotal erythema. The primary differential diagnosis is torsion of the testis or appendix testis. Often, there is a simultaneous UTI. Frequently, an associated

Table 6. Physician office visits by children with urinary tract infections, 1992–2000 (merged), count (95% CI), number of visits, percentage of visits, rate[a] (95% CI)

	5-Year Count (95% CI)	Total No. Visits by Male/Females <18, 1992–2000	% of Visits	5-Year Rate (95% CI)
Primary diagnosis	5,556,971 (4,502,468–6,611,474)	809,286,031	0.7	7,949 (6,440–9,457)
Any diagnosis	7,171,390 (5,995,021–8,347,759)	809,286,031	0.9	10,258 (8,575–11,941)

[a]Rate per 100,000 based on the sum of weighted counts in 1992, 1994, 1996, 1998, and 2000 over the mean estimated base population across those five years. Population estimates from Current Population Survey (CPS), CPS Utilities, Unicon Research Corporation, for relevant demographic categories of US civilian non-institutionalized population under age 18.

SOURCE: National Ambulatory Medical Care Survey, 1992, 1994, 1996, 1998, 2000.

Table 7. Hospital outpatient visits by children with urinary tract infections, 1994–2000 (merged), count (95% CI), number of visits, percentage of visits, rate[a] (95% CI)

	4-Year Count (95% CI)	Total No. Visits by Males/Females <18, 1994–2000	% of Visits	4-Year Rate (95% CI)
Primary diagnosis	374,907 (298,369–451,445)	72,578,652	0.5	529 (421–637)
Any diagnosis	527,424 (430,174–624,674)	72,578,652	0.7	744 (607–882)

[a]Rate per 100,00 based on the sum of weighted counts in 1994, 1996, 1998, and 2000 over the mean estimated base population across those four years. Population estimates from Current Population Survey (CPS), CPS Utilities, Unicon Research Corporation, for relevant demographic categories of US civilian non-institutionalized population under age 18.

SOURCE: National Hospital Ambulatory Medical Care Survey, 1994, 1996, 1998, 2000.

predisposing factor, such as urethral obstruction, ectopic ureter, neurogenic bladder dysfunction, or recent catheterization, is present. On rare occasions, orchitis may be caused by hematogenous spread of bacteria. Nonbacterial epididymitis can also result from vasal reflux of urine causing an inflammatory response. Rare, nonbacterial cases include viral, tuberculous, and mumps orchitis.

HCUP data indicate that inpatient hospitalization for orchitis is rare, 1.6 per 100,000 in 2000 (Table 8). MarketScan data from 1999 indicate that despite the general recommendation for antimicrobial treatment for orchitis, only 22% of children treated in physicians' offices or hospital outpatient clinics received an antimicrobial within a week of the visit, and only 43% received an antimicrobial within a year of the visit (Table 9). Of those treated in ERs, 56% received an antimicrobial. In the ER, adolescents were twice as likely to receive an antimicrobial as were boys 3 to 10 years of age. The unexpectedly low utilization of antimicrobials may be due in part to incorrect coding, as many children with torsion of the appendix testis are misclassified as having epididymitis despite the absence of infection. The higher rate of antimicrobial usage in adolescents may represent an appropriate understanding that the true infectious form of this disease is more common in this age group. Greater rigor in diagnosis and terminology is necessary to utilize antimicrobials appropriately in the treatment of patients with orchitis.

ECONOMIC IMPACT

Direct Cost

Pediatric UTIs are a significant source of healthcare expenditures. Data analyzed for this chapter are limited to the immediate costs of

Table 8. Inpatient hospital stays for children with orchitis[a], count, rate[b]

Year	Count	Rate
1994	1,036	3.0
1996	777	2.1
1998	576	1.6
2000	612	1.6

[a]Orchitis defined as ICD-9 code 604.xx.

[b]Rate per 100,000 based on 1994, 1996, 1998, 2000 population estimates from Current Population Survey (CPS), CPS Utilities, Unicon Research Corporation, for relevant demographic categories of US male civilian non-institutionalized population under age 18.

SOURCE: Healthcare Cost and Utilization Project Nationwide Inpatient Sample, 1994, 1996, 1998, 2000.

Table 9. Use of antibiotics in the treatment of pediatric orchitis, 1999

	# of boys who had a physician office visit or hospital outpatient visit for orchitis	% of boys w/ office visit who received an antibiotic within a year of the visit	% of boys w/ office visit who received an antibiotic within a week of the visit	# of boys who had an ER visit for orchitis	% of boys w/ ER visit who received an antibiotic within a year of the visit	% of boys w/ ER visit who received an antibiotic within a week of the visit
Total	60	43%	22%	9	56%	56%
Age						
0–2	5	40%	0%	0		
3–10	12	58%	33%	3	33%	33%
11–17	43	40%	21%	6	67%	67%
Region						
Midwest	23	48%	26%	3	33%	33%
Northeast	13	23%	15%	3	33%	33%
South	17	47%	18%	0		
West	4	50%	25%	3	100%	100%
Unknown	3	67%	33%	0		

SOURCE: MarketScan, 1999.

treatment of the acute infection; however, UTI is frequently a manifestation of a larger underlying condition. Hence, much of the economic burden of diagnosing and treating the related conditions is not included here. Costs are not included for follow-up imaging, long-term antimicrobials, or treatment of anatomic abnormalities, dysfunctional elimination, and neurological abnormalities. Also not included in these analyses are long-term costs related to the sequelae of repeated pyelonephritis and scarring, such as hypertension or renal insufficiency.

According to data from the National Association of Children's Hospitals and Related Institutions (NACHRI), the mean cost per child admitted for a UTI from 1999 to 2001 was $4,501 (Table 10). The cost was higher among adolescents ($6,796) than among infants ($4,069) or older children ($4,554). Costs were higher for boys ($5,165) than for girls ($4,094). Costs were highest in the Northeast ($5,518) and lowest in the Midwest ($3,948). No racial/ethnic differences in costs were apparent. Inpatient costs per admission rose from $3,869 in 1999 to $4,444 in 2000 and $5,145 in 2001, although the increase was not caused by significant changes in any particular gender, geographic, or racial/ethnic group (Table 11).

Despite shorter length of stay for all groups analyzed between 1999 and 2001 (Table 12), nominal costs increased in all regions of the country (Table 11) in children hospitalized for UTI. Although hospitalized less often than girls (Tables 4 and 5), boys had higher inpatient costs (Table 10), no doubt related to their longer hospital stays, a finding noted in data from both NACHRI (Table 12) and HCUP (Table 13). Stays were longer in urban teaching hospitals, a finding likely related to differences in case mix between teaching and nonteaching facilities. The general trend toward shorter length of stay for UTI may reflect changing practice patterns in the management of uncomplicated UTI, with a greater reliance on outpatient oral antimicrobials to complete the therapeutic course initiated in the hospital. Nonetheless, the data suggest that inpatient costs have risen, despite efforts to decrease them through shorter hospital stays. Caution should be used in interpreting this trend, because these costs are not adjusted for inflation.

Given an average of 40,000 hospitalizations per year for UTIs (Table 2) and an average cost of $4,500 per inpatient episode (Table 10), a rough estimate of the annual economic burden for inpatient treatment of UTI would be $180 million. However, it is important to remember that while inpatient is by far the most expensive treatment setting, it represents a small fraction of UTI care. Hence, comprehensive estimates of the financial burden of pediatric UTI also need to incorporate the costs of outpatient and ER care, as well as those associated with evaluating and treating associated conditions.

Table 10. Inpatient cost per child admitted with urinary tract infection listed as primary diagnosis, 1999–2001, mean cost[a] (95% CI)

	Count	Mean Cost	
Total[b]	16,024	$4,501	(4,324–4,678)
Age			
0–2	10,383	$4,069	(3,963–4,175)
3–10	3,774	$4,554	(4,177–4,930)
11–17	1,867	$6,796	(5,630–7,963)
Race/ethnicity			
White	7,807	$4,500	(4,263–4,737)
Black	2,862	$4,730	(4,158–5,302)
Asian	300	$4,569	(3,966–5,172)
Hispanic	3,050	$4,778	(4,364–5,192)
American Indian	39	$8,851	(475–17,227)
Gender			
Male	6,092	$5,165	(4,776–5,554)
Female	9,932	$4,094	(3,938–4,249)
Region			
Midwest	4,635	$3,948	(3,812–4,084)
Northeast	850	$5,518	(4,794–6,241)
South	7,900	$4,864	(4,535–5,194)
West	2,363	$4,531	(4,259–4,804)

[a]Calculated using adjusted ratio of costs to charges, including variable and fixed cost among participating children's hospitals.
[b]Children of other races and missing race/ethnicity or region are included in the total.
SOURCE: National Association of Children's Hospitals and Related Institutions, 1999–2001.

Indirect Cost

Because children do not contribute direct economic support in most families, the impact of lost productivity or time off from school cannot be determined. However, an ill child usually means work loss for parents and, as such, may generate

Table 11. Inpatient cost per child admitted with urinary tract infection listed as primary diagnosis, count, mean cost[a] (95% CI)

	1999			2000			2001		
	Count	Mean Cost		Count	Mean Cost		Count	Mean Cost	
Total[b]	5,039	$3,869	(3,706–4,033)	5,551	$4,444	(4,182–4,706)	5,434	$5,145	(4,726–5,564)
Age									
0–2	3,248	$3,702	(3,498–3,906)	3,617	$3,954	(3,827–4,081)	3,518	$4,526	(4,315–4,738)
3–10	1,223	$3,611	(3,417–3,805)	1,287	$5,357	(4,314–6,399)	1,264	$4,648	(4,331–4,964)
11–17	568	$5,381	(4,630–6,132)	647	$5,365	(4,867–5,863)	652	$9,450	(6,216–12,684)
Race/ethnicity									
White	2,525	$3,951	(3,769–4,132)	2,600	$4,286	(4,058–4,513)	2,682	$5,226	(4,595–5,857)
Black	867	$4,227	(3,511–4,943)	1,011	$4,386	(3,968–4,804)	984	$5,526	(4,047–7,005)
Asian	87	$4,041	(3,256–4,827)	100	$4,571	(3,416–5,727)	113	$4,973	(3,881–6066)
Hispanic	749	$3,562	(3,376–3,748)	1,087	$5,327	(4,236–6,418)	1,214	$5,036	(4,704–5,369)
American Indian	5	$2,737	(705–4,768)	17	$15,163	(0–35,084)	17	$4,337	(2,879–5,795)
Gender									
Male	1,877	$4,327	(3,946–4,709)	2,114	$4,697	(4,427–4,966)	2,101	$6,384	(5,346–7,423)
Female	3,162	$3,598	(3,468–3,727)	3,437	$4,288	(3,898–4,678)	3,333	$4,364	(4,171–4,557)
Region									
Midwest	1,505	$3,481	(3,277–3,686)	1,596	$3,934	(3,762–4,106)	1,534	$4,420	(4,111–4,730)
Northeast	180	$4,929	(4,062–5,796)	325	$5,034	(3,922–6,145)	345	$6,281	(4,907–7,655)
South	2,399	$4,261	(3,973–4,549)	2,744	$4,799	(4,328–5,270)	2,757	$5,454	(4,673–6,235)
West	800	$3,937	(3,593–4,281)	765	$4,684	(4,050–5,319)	798	$4,981	(4,579–5,382)

[a]Calculated using adjusted ratio of costs to charges, including variable and fixed cost among participating children's hospitals.

[b]Children of other races and missing race/ethnicity or region are included in the totals.

SOURCE: National Association of Children's Hospitals and Related Institutions, 1999–2001.

substantial indirect costs. Better tools are needed to assess the parental economic impact of pediatric UTI.

PREVENTION

Strategies to prevent UTI primarily revolve around enhancing host defenses. Such practices as proper hygiene, good voiding habits, and relief of constipation are the primary methods for preventing uncomplicated infections. In some patients, prophylactic antimicrobials may be beneficial. For those with complicated UTIs, the correction of underlying anatomic abnormalities or the institution of adaptive approaches, such as intermittent catheterization, can be important. Efforts to reduce nosocomial infections though proper catheter management and to prevent resistance through more selective use of antimicrobials are increasing.

From a public health standpoint, there is continuing debate over the roles of both routine newborn circumcision and sibling screening for reflux once an index case is identified. Prenatal ultrasound screening may decrease the burden of illness by identifying anatomic abnormalities prior to the first infection.

RECOMMENDATIONS

The management of patients with acute uncomplicated UTI is well established, but ongoing efforts are likely to streamline diagnosis and treatment. Further research is needed to optimize the evaluation phase following the diagnosis of UTI in order to improve quality of care and decrease cost. To ensure proper access to care for all children, investigation is needed into who is and who is not receiving appropriate evaluation. In addition, there is a need for greater education among parents and healthcare providers regarding the role of dysfunctional voiding and constipation in UTI risk.

Table 12. Trends in mean inpatient length of stay (days) for children hospitalized with urinary tract infection listed as primary diagnosis (95% CI)

	1999		2000		2001	
	Count	Length of Stay	Count	Length of Stay	Count	Length of Stay
Total	5039	3.7 (3.6–3.8)	5551	3.6 (3.5–3.8)	5434	3.6 (3.6–3.7)
Age						
0–2	3,248	3.8 (3.6–4.0)	3,617	3.5 (3.4–3.6)	3,518	3.7 (3.6–3.8)
3–10	1,223	3.4 (3.2–3.5)	1,287	3.8 (3.3–4.3)	1,264	3.3 (3.1–3.4)
11–17	568	3.9 (3.5–4.2)	647	3.8 (3.5–4.1)	652	4.3 (3.8–4.7)
Race/ethnicity						
White	2,525	3.4 (3.3–3.5)	2,600	3.3 (3.2–3.4)	2,682	3.5 (3.3–3.6)
Black	867	4.2 (3.5–5.0)	1,011	3.8 (3.3–4.4)	984	3.7 (3.5–4.0)
Asian	87	3.3 (2.8–3.8)	100	3.4 (2.8–4.1)	113	3.7 (3.1–4.4)
Hispanic	749	3.7 (3.5–3.8)	1,087	4.0 (3.8–4.3)	1,214	4.0 (3.8–4.2)
American Indian	5	2.2 (0.8–3.6)	17	6.2 (2.9–9.4)	17	3.5 (2.4–5.5)
Other	325	3.9 (3.4–4.3)	345	3.4 (3.1–3.7)	242	3.4 (3.0–3.7)
Missing	481	4.3 (4.0–4.6)	391	3.9 (3.5–4.3)	182	3.3 (3.0–3.6)
Gender						
Male	1,877	4.2 (3.8–4.5)	2,114	3.9 (3.8–4.1)	2,101	4.1 (3.9–4.3)
Female	3,162	3.4 (3.3–3.5)	3,437	3.4 (3.2–3.6)	3,333	3.3 (3.2–3.4)
Region						
Midwest	1,505	3.2 (3.1–3.4)	1,596	3.1 (3.0–3.2)	1,534	3.2 (3.1–3.4)
Northeast	180	3.8 (3.2–4.4)	325	3.4 (3.1–3.8)	345	3.4 (3.0–3.7)
South	2,399	4.1 (3.8–4.4)	2,744	3.9 (3.7–4.2)	2,757	3.9 (3.8–4.1)
West	800	3.2 (3.0–3.4)	765	3.5 (3.2–3.8)	798	3.5 (3.3–3.7)
Missing	155	4.2 (3.6–4.8)	120	5.1 (4.3–5.9)	0	

SOURCE: National Association of Children's Hospitals and Related Institutions, 1999–2001.

For hospitalized patients, urethral catheterization remains the primary risk factor for nosocomial UTI. Enhanced awareness of the morbidity and cost of this complication should lead to more judicious use of catheters and improved protocols for their management.

Table 13. Trends in mean length of stay (days) for children hospitalized with urinary tract infection listed as primary diagnosis

	Length of Stay			
	1994	1996	1998	2000
Total	4.2	3.6	3.4	3.1
Age				
0–2	4.7	3.9	3.6	3.4
3–10	3.7	3.2	3.1	2.8
11–17	3.5	3.0	3.1	2.7
Gender				
Male	4.9	4.2	4.0	3.7
Female	3.8	3.3	3.1	2.9
Race/ethnicity				
White	3.7	3.3	3.1	2.9
Black	5.1	4.2	4.0	3.6
Asian/Pacific Islander	4.8	4.1	3.6	4.2
Hispanic	4.4	4.2	4.2	3.6
Other	6.8	4.4	3.3	3.6
Region				
Midwest	3.5	3.2	2.9	2.8
Northeast	5.0	4.0	3.5	3.6
South	4.2	3.7	3.5	3.2
West	3.8	3.5	3.6	3.0
MSA				
Rural	3.5	3.0	2.8	2.6
Urban	4.3	3.7	3.5	3.2
Hospital Type				
Rural	3.5	3.0	2.8	2.6
Urban nonteaching	3.7	3.4	3.1	3.1
Urban teaching	4.9	4.1	3.7	3.4

MSA, metropolitan statistical area.

SOURCE: Healthcare Cost and Utilization Project Nationwide Inpatient Sample, 1994, 1996, 1998, 2000.

REFERENCES

1. Struthers S, Scanlon J, Parker K, Goddard J, Hallett R. Parental reporting of smelly urine and urinary tract infection. Arch Dis Child 2003;88:250-2.
2. Bulloch B, Bausher JC, Pomerantz WJ, Connors JM, Mahabee-Gittens M, Dowd MD. Can urine clarity exclude the diagnosis of urinary tract infection? Pediatrics 2000;106:E60.
3. Isaacman DJ, Burke BL. Utility of the serum C-reactive protein for detection of occult bacterial infection in children. Arch Pediatr Adolesc Med 2002;156:905-9.
4. 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.
5. Rushton HG, Majd M. Dimercaptosuccinic acid renal scintigraphy for the evaluation of pyelonephritis and scarring: a review of experimental and clinical studies. J Urol 1992;148:1726-32.
6. Haycock GB. A practical approach to evaluating urinary tract infection in children. Pediatr Nephrol 1991;5:401-2; discussion 403.
7. Puri P, Cascio S, Lakshmandass G, Colhoun E. Urinary tract infection and renal damage in sibling vesicoureteral reflux. J Urol 1998;160:1028-30; discussion 1038.
8. Fussell EN, Kaack MB, Cherry R, Roberts JA. Adherence of bacteria to human foreskins. J Urol 1988;140:997-1001.
9. Shortliffe LM, McCue JD. Urinary tract infection at the age extremes: pediatrics and geriatrics. Am J Med 2002;113 Suppl 1A:55S-66S.
10. Jakobsson B, Esbjorner E, Hansson S. Minimum incidence and diagnostic rate of first urinary tract infection. Pediatrics 1999;104:222-6.
11. Wiswell TE, Hachey WE. Urinary tract infections and the uncircumcised state: an update. Clin Pediatr (Phila) 1993;32:130-4.
12. Schoen EJ, Colby CJ, Ray GT. Newborn circumcision decreases incidence and costs of urinary tract infections during the first year of life. Pediatrics 2000;105:789-93.
13. Hoberman A, Wald ER, Hickey RW, Baskin M, Charron M, Majd M, Kearney DH, Reynolds EA, Ruley J, Janosky JE. Oral versus initial intravenous therapy for urinary tract infections in young febrile children. Pediatrics 1999;104:79-86.
14. Laumann EO, Masi CM, Zuckerman EW. Circumcision in the United States. Prevalence, prophylactic effects, and sexual practice. JAMA 1997;277:1052-7.