

Prevalence of Urinary Tract Infection in Febrile Young Children in the Emergency Department

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ABSTRACT. *Objective.* Establish prevalence rates of urinary tract infection (UTI) in febrile infants and young girls in an emergency department (ED) by demographics and clinical parameters.

Methods. Cross-sectional prevalence survey of 2411 (83%) of all infants younger than 12 months and girls younger than 2 years of age presenting to the ED with a fever ($\geq 38.5^{\circ}\text{C}$) who did not have a definite source for their fever and who were not on antibiotics or immunosuppressed. Otitis media, gastroenteritis, and upper respiratory infection were considered potential but not definite sources of fever.

Results. Overall prevalence of UTI (growth of $\geq 10^4$ CFU/mL of a urinary tract pathogen) was 3.3% (95% confidence interval [CI]: 2.6,4.0). Higher prevalences occurred in whites (10.7%; 95% CI: 7.1,14.3), girls (4.3%; 95% CI: 3.3,5.3), uncircumcised boys (8.0%; 95% CI: 1.9,14.1), and those who did not have another potential source for their fever (5.9%; 95% CI: 3.8,8.0), had a history of UTI (9.3%; 95% CI: 3.0,20.3), malodorous urine or hematuria (8.6%; 95% CI: 2.8,19.0), appeared "ill" (5.7%; 95% CI: 4.0,7.4), had abdominal or suprapubic tenderness on examination (13.2%; 95% CI: 3.7,30.7), or had fever $\geq 39^{\circ}\text{C}$ (3.9%; 95% CI: 3.0,4.8). White girls had a 16.1% (95% CI: 10.6,21.6) prevalence of UTI.

Conclusions. UTI is prevalent in young children, particularly white girls, without a definite source of fever. Specific clinical signs and symptoms of UTI are uncommon, and the presence of another potential source of fever such as upper respiratory infection or otitis media is not reliable in excluding UTI. *Pediatrics* 1998;102(2). URL: <http://www.pediatrics.org/cgi/content/full/102/2/e16>; UTI, evaluation of febrile infants, prevalence.

ABBREVIATIONS. UTI, urinary tract infection; ED, emergency department; URI, upper respiratory infection; CI, confidence interval; WBC, white blood cell; GI, gastrointestinal.

Nuclear renal scans suggest that the vast majority of febrile young children with urinary tract infection (UTI) have pyelonephritis, putting them at risk for renal scarring and the long-term sequelae of hypertension and renal failure.¹⁻⁴ It is imperative that physicians identify these children

to institute early treatment, evaluate the urinary tract, and monitor for recurrent UTI.⁴

Unfortunately, the classic signs of UTI and pyelonephritis in older children and adults are not present or easily discerned in the toddler or young child. Fever is the most common symptom of UTI in the infant.^{5,6} Also, the presence of another source of fever on examination, such as otitis media or other viral symptoms, does not exclude a UTI.⁷⁻⁹ Screening for UTI is uncomfortable for patients, time-consuming for staff, and expensive in the aggregate. Physicians throughout the United States vary in their clinical practice of when to obtain a urine culture in a febrile infant.^{10,11}

Community studies suggest that boys younger than 1 year of age and girls younger than 5 years of age are most at risk for UTI.⁵ The literature estimates that the prevalence of UTI in febrile children presenting for outpatient evaluation ranges from 1% to 20%.^{7-9,12} The studies vary in their definition of UTI, method of urine collection, and eligibility criteria. Most have small sample sizes, and none have been true prevalence studies in which data are collected on all children.

The aims of this study were 1) to establish prevalence rates of UTI among young febrile children seen in an urban emergency department (ED), and (2) to evaluate the effect of age, sex, race, and clinical symptoms and signs on the prevalence rates of UTI.

METHODS

Study Design and Subjects

This was a cross-sectional study of the current clinical practice over a 1-year period in our urban children's hospital emergency department. Boys younger than 1 year and girls younger than 2 years of age were eligible for the study if they had a rectal temperature $\geq 38.5^{\circ}\text{C}$, were not taking antibiotics, were not immunosuppressed, and did not have a definite source of fever on examination (Table 1). Children were included in the study if they had a minor potential source of fever such as gastroenteritis, otitis media, upper respiratory infection (URI), or nonspecific rash. Urine cultures and blood cultures were obtained on these children as part of routine clinical practice in our ED. During a 2-month pilot period, physician/physician interobserver reliability was measured for clearly defined clinical parameters, and only those items with a κ statistic of >0.4 were used for a questionnaire. This questionnaire was completed by the examining physician and nurse at the time, and a urine culture was obtained. A team of seven nurse researchers monitored all ED charts daily for patient eligibility, urine and blood culture results, and questionnaire completion. The study was reviewed and approved by our institutional review board.

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TABLE 1. Eligibility and Exclusion Criteria for Study

Eligibility criteria	
Temperature $\geq 38.3^{\circ}\text{C}$ in the ED	
Boys <1 year	
Girls <2 years	
No source or minor potential source of fever as determined by examining physician	
Example	
Otitis media	(Visualization of redness, loss of landmarks, or abnormal movement of tympanic membrane)
URI	(Rhinnorhea, cough, upper airway sounds)
Gastroenteritis	(Abnormal frequency of monofluid or watery stools)
Viral exanthem	(Rash not identified as having one definite virus as an etiology)
Exclusions	
Definite Source of Fever	
Example	
Confirmed bacterial infection	
Meningitis by cerebrospinal fluid cell count	
Group A β -hemolytic streptococci— \oplus rapid test or culture	
Pneumonia by chest radiograph	
Septic arthritis by joint aspirate	
By examination	
Cellulitis	Perforated otitis media with exudate
Adenitis	Scarlet fever
Osteomyelitis	
Specific viral infection by examination	
Varicella	Herpetic stomatitis
Coxsackie disease	Bronchiolitis
Measles	
Recognizable febrile disease	
Kawasaki's disease	Henoch-Schonlein purpura
Current antibiotic therapy	
Immunodeficiency (ANC < 500)	
Caretaker absent or unable to communicate	

Culture Technique and Definitions

Urine cultures were routinely obtained on children younger than 2 years of age by urethral catheterization by experienced ED nurses using standard sterile technique. Urine specimens were then sent to the microbiology laboratory in sterile containers by pneumatic tube. Urine was refrigerated, if not plated, within 10 minutes of receipt. Standard quantitative culture was performed by laboratory technologists. A loop calibrated to deliver approximately 0.001 mL was used to inoculate blood and MacConkey agar plates. All plates were incubated at 35°C and examined daily for growth for 2 days. A positive result was defined as growth of a single urinary tract pathogen at $\geq 10^4$ CFU/mL.¹³

Statistical Analysis

Prevalence rates with 95% confidence intervals (CIs) were calculated for the study sample and comparison subgroups. Comparisons were made between categorical variables using χ^2 test of proportions or, in the case of small samples, Fisher's exact test, with $P \leq .05$ being the a priori significance level. Multiple logistic regression was used to evaluate the possibility of confounding in the relationship between race and UTI.

RESULTS

Description of the Study Sample

Over the study period of February 2, 1995 to February 14, 1996, 4452 children presented to the ED who met the temperature, sex, and age criteria. Greater than one third (1544) were excluded, with the most common reasons being concurrent use of antibiotics (26%), bronchiolitis (29%), pneumonia (18%), stomatitis (5%), croup (4%), perforated otitis media (4%), cellulitis (3%), and varicella (3%). Children with immunosuppression or with no caretaker present to answer study questions were responsible for <1%.

Of those eligible for the study, 83% (2411 of 2908) had urine cultures obtained, and 89% of these (2155) had a prospective questionnaire completed by the examining physicians. Those children who had urine cultures obtained were slightly younger (9.6 vs 10.3 months; $P < .001$), more likely to be described as "ill appearing or toxic" (29.7% vs 8.4%; $P < .001$), and had higher temperatures (39.4°C vs 39.0°C). There was no difference between those who did or did not have urine cultures obtained with regard to sex, race, ED shift, presence of another potential source of fever, city residence, or insurance type. Agreement between 29 physician observer pairs on questionnaire variables was quite high (κ statistic = 0.81; range 0.56 to 1.0). Agreement for greater than 200 RN/MD and RN/RN pairs on historical information, which may be completed by either a nurse or a physician, had κ statistics ≥ 0.6 .

In our urban ED study sample, 61% were girls and 87% of the boys were circumcised. The majority were African-American (84%), had fever $\geq 39^{\circ}\text{C}$ in the ED (67%), were described as well-appearing (68%), and had a potential source for their fever on examination (80%). Other potential sources of fever included URI (49%), otitis media (45%), gastroenteritis (19%), or viral exanthem (5%). One third reported another ill contact at home. Many had nonspecific symptoms that could indicate UTI such as vomiting (38%), diarrhea (28%), poor feeding (45%), or fever ≥ 2 days (58%). Specific signs or symptoms related to the urinary tract included a history of malodorous urine (3%) or hematuria (5 patients); medical history of

UTI or renal anomalies (3%); and suprapubic (5 patients), abdominal (12%), or flank pain (6 patients) on examination.

Prevalence of UTI

There were 80 positive results, 79% (63) in girls. All cultures were obtained by urethral catheterization. The predominant urinary tract pathogen was *Escherichia coli* (93%), with 2% *Enterococcus*, and one culture each of *Enterobacter cloacae*, Group A β -hemolytic streptococci *Staphylococcus aureus*, and *Pseudomonas*. The majority (79%) had growth of $\geq 100\,000$ CFU/mL, whereas 12% had 50 000 to 99 000 CFU/mL, and 9% had between 10 000 and 50 000 CFU/mL. The majority (86%) had evidence of pyuria (≥ 5 white blood cells [WBCs] per high powered field in spun urine by microscopy, positive leukocyte esterase on dipstick, or ≥ 10 WBC/mm³ in unspun urine by cytometer) or bacteriuria (positive nitrite on dipstick or bacteria seen on Gram stain or microscopy). The majority of these infants with positive results were admitted to the hospital (75%), and all were treated with antibiotics, either initially or when results of the culture were known. In accordance with current practice by nephrologists at our institution, only 4 children underwent nuclear scans. Two infants, both 2-month-old girls, were bacteremic with *E coli*.

Table 2 lists the prevalence of UTI by sex, race, age, and clinical parameters. Overall prevalence of UTI was 3.3% (95% CI: 2.6,4.0), with higher prevalence in girls and whites. Strikingly, white girls had a 16.1% (95% CI: 10.6,21.6) prevalence rate of UTI and white boys had prevalence rates similar to nonwhite girls of 2.5%, whereas nonwhite boys had the lowest rates of UTI. This association between race and UTI in girls did not change when adjusted for ZIP code of residence or insurance type, or presence of another potential source of fever, which may be markers for socioeconomic status or referral bias. The adjusted odds ratio for white race was 9.7 (95% CI: 5.1,18.5; $P < .001$). Although the number of UTIs in boys was small and the prevalence rates show wide confidence intervals, it is clear that boys beyond the neonatal period still are at risk for UTI, with a prevalence from 6 to 11 months of age of 1.7% (95% CI: 0.5,2.6). The prevalence rate of UTI in girls is highest in the first year of life ($P < .001$).

Several clinical parameters were associated with a higher rate of UTI. Those children who did not have a potential source of fever or appeared ill to the examining physician had higher UTI prevalence, 5.9% and 5.7%, respectively, than those without a potential source of fever or who appeared "well." A febrile white girl without another potential source of fever on examination had a prevalence of UTI of 30.6% (95% CI: 18.3,45.4). Boys who were not circumcised were eight times more likely to have UTI. Those with higher fever in the ED also had a higher prevalence of UTI. Children whose caregivers reported a medical history of UTI or change in the urine such as malodor, although infrequent, were associated with UTI. Tenderness also was found on palpating the abdomen or suprapubic area in more

TABLE 2. Prevalence of UTI in Girls < 2 Years and Boys < 1 Year With Fever

	N	Percent	
		Prevalence (95% CI)	P Value
Overall	2411	3.3 (2.6–4.0)	
Demographics			
Sex			
Girls	1469	4.3 (3.3–5.3)	<.001
Boys	942	1.8 (1.0–2.6)	
Race			
White	291	10.7 (7.1–14.3)	<.001
African-American	2014	2.1 (1.5–2.7)	
Other	106	5.7 (1.3–10.1)	
Sex/race			
Girls			
White	174	16.1 (10.6–21.6)	<.001
Nonwhite	1295	2.7 (1.9–3.7)	
Boys			
White	117	2.6 (0.5–7.3)	.52
Nonwhite	825	1.7 (0.9–2.8)	
Age/sex			
Boys			
<6 Mo	391	2.7 (1.2–4.7)	.14
≥ 6 Mo	551	1.3 (0.5–2.6)	
Girls			
<12 Mo	813	6.0 (4.5–7.9)	<.001
≥ 12 Mo	656	2.1 (1.2–3.6)	
Clinical parameters			
Potential source of fever			
Yes	1858	2.7 (2.0–3.4)	<.001
No	474	5.9 (3.8–8.0)	
General appearance			
Well	1650	2.4 (1.7–3.1)	<.001
Ill	681	5.7 (4.0–7.4)	
Circumcision			
Yes	497	1.2 (0.2–2.2)	<.002
No	75	8.0 (1.9–14.1)	
Fever			
$\geq 39^\circ\text{C}$	1623	3.9 (3.0–4.8)	<.003
< 39°C	788	2.2 (1.2–3.2)	
Any tenderness on examination			
Yes	30	13.2 (3.7–30.7)	<.02
No	2091	3.2 (2.4–4.0)	
Medical history of UTI			
Yes	54	9.3 (3.0–20.3)	<.03
No	2049	3.2 (2.4–4.0)	
Any urine symptoms			
Yes	58	8.6 (2.8–19.0)	<.04
No	2060	3.2 (2.4–4.0)	

infants with UTI. The presence of gastrointestinal (GI) symptoms such as vomiting or diarrhea, history of poor feeding, exposure to ill contacts, and length of fever were not found to be associated with UTI.

DISCUSSION

Few studies have looked specifically at distinguishing children with UTI from those presenting to an ED or outpatient setting for evaluation with fever. This is the first true prevalence study of UTI in febrile young children in the literature. Our capture rate of $>80\%$ of those children eligible for the study minimizes the effect of sampling bias common in previous studies, which used convenience samples,^{7–9} selected those felt to be at higher risk for UTI by the examining physician,^{8,9} or included infants only in the neonatal period or first year of life.¹²

Our striking prevalence of UTI in white children does not appear to be attributable to sampling bias. A previous report from another large ED sample with 56% whites found a remarkably similar rate.⁷ White female infants whose highest temperature had been $\geq 39^{\circ}\text{C}$ had a prevalence of UTI of 16.0%, compared to 16.1% (95% CI:10.6,21.6) prevalence in our study. Kunin and colleagues also found that the prevalence of asymptomatic bacteremia was higher among white school girls (1.2%), compared with African-American girls of the same age (0.7%).¹⁴ We hypothesize that this racial difference may be attributable to differences in blood group antigens on the surface of uroepithelial cells that may affect *E coli* adherence.¹⁵ Additional study is needed to substantiate or refute this hypothesis.

A current pediatric emergency medicine and infectious disease consensus opinion is to obtain urine cultures only in boys younger than 6 months and in girls younger than 2 years of age with fever without a documented source.¹⁰ Bronchiolitis was considered a documented source of fever for which a urine culture is not routinely obtained in this study. This practice is supported by a multicenter study that found a 1.9% prevalence of UTI in febrile infants with bronchiolitis.¹⁶ Although the prevalence of UTI is higher in those children without any other potential source of fever, we found a 2.7% (95% CI: 2.0,3.4) prevalence compared with another urban ED's 3.5% (95% CI: 1.8,5.2) prevalence rate in a convenience sample of febrile infants with a possible source of fever.⁷ In another study of children younger than 2 years of age who presented with URI or GI symptoms felt by the attending physician to be insufficient to explain fever or without any source of fever on examination, 4.1% had UTIs.⁹ Physicians should consider the possibility of UTI in young febrile children who have another potential source of fever such as URI or gastroenteritis.

The literature is unclear about the age UTI becomes less prevalent for boys and girls. Our data suggest that girls younger than 1 year of age are at higher risk for UTI than those in the second year of life. Because of our small number of boys with UTI, we are not able to determine whether boys younger than 6 months are more at risk than those 6 to 12 months of age. The large variation in prevalence of UTI in boy infants among studies may be attributable to difference in circumcision status. Crain and co-workers¹² found a 12.4% (95% CI: 7.6,17.3) prevalence of UTI in febrile boys younger than 8 weeks of age, of whom 82% were uncircumcised. Hoberman et al⁷ found a prevalence of 2.9% (95% CI: 1.1,6.2) in boys of similar age, of whom only 2% were uncircumcised. We found that boys who were uncircumcised were eight times more likely to have UTI than those who were circumcised, consistent with a 10-fold increase in uncircumcised boys found by Wiswell and colleagues in a cohort of military families.¹⁷

Few clinical symptoms or signs appear to indicate UTI in febrile young infants. Although GI symptoms of poor feeding, vomiting, and diarrhea are reported in many infants admitted for UTI,^{5,6} the prevalence of UTI was not higher in this group. Specific signs of

UTI such as changes in the urine odor or hematuria; tenderness of the abdominal, flank, or suprapubic areas on examination; or medical history of UTI were associated with higher prevalence of UTI but were uncommonly elicited. Nonspecific findings of higher fever and ill general appearance were strongly associated with UTI.

We chose a conservative definition of UTI,¹³ comparable with that used in a previous paper on UTI prevalence,⁷ and did not use urinalysis or dipstick results as criteria for obtaining or interpreting urine cultures. There is much debate in the literature regarding the definition of a positive result from urine obtained by catheterization. The amount of growth considered positive varies from 10^3 to 10^5 CFU/mL. Recently, Hoberman and associates have argued that $\geq 50\,000$ CFU/mL should be considered the cut-off, based on the amount of pyuria observed at this level compared with lesser growth levels.¹⁸ If $>50\,000$ CFU/mL is used to define a positive result, in this study 7 children would have been classified as having negative results; 3 of these (43%) were girls with high fevers $\geq 39.5^{\circ}\text{C}$ who had significant pyuria (≥ 25 WBC/HPF) and pure growth of *E coli*. No absolute cut-off can predict perfectly the presence or absence of UTI. A few children with growth $<10^4$ had evidence of pyuria and were treated for UTI, whereas 10% of children with $\geq 10^5$ lacked evidence of pyuria. Although some of these children may have asymptomatic bacteriuria, the prevalence of asymptomatic bacteria is reported to be low, $\sim 1\%$.¹⁹ However, pyuria as determined by standard urinalysis is not necessarily present on initial urinalysis even with documented pyelonephritis on nuclear scan in febrile young infants^{20,21} or by suprapubic aspiration.²²

Our prevalence rates and recommendations are based on one sample of children presenting to an urban, tertiary care children's hospital ED and may not be generalized to all patient populations and clinical practices. Despite differences in practice or setting, it is imperative that physicians identify the febrile child with UTI.

Our study supports the observation of others that UTI may be underdiagnosed in febrile infants and confirms our current clinical practice of obtaining urine cultures on febrile infants without a definite source of fever on examination.⁷ Prevalence rates of UTI, however, appear to vary by sex, race, degree of fever, circumcision status, and whether another potential source of fever is apparent on examination.^{5-9,12,16,17} Febrile infant girls who are white and uncircumcised boys appear to have the highest prevalence of UTI. We are currently using these prevalence data to develop a clinical prediction model to guide clinicians further about when to obtain urine cultures.

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