Association of Malodorous Urine With Urinary Tract Infection in Children Aged 1 to 36 Months

OBJECTIVE: To determine whether parental reporting of malodorous urine is associated with urinary tract infection (UTI) in children.

METHODS: We conducted a prospective consecutive cohort study in the emergency department of a pediatric hospital from July 31, 2009 to April 30, 2011. All children aged between 1 and 36 months for whom a urine culture was prescribed for suspected UTI (ie, unexplained fever, irritability, or vomiting) were assessed for eligibility. A standardized questionnaire was administered to the parents by a research assistant. The primary outcome measure was a UTI.

RESULTS: Three hundred ninety-six children were initially enrolled, but 65 were excluded a posteriori either because a urine culture, although prescribed, was not done (11), was collected by bag (39), and/or showed gross contamination (25). Therefore, 331 children were included in the final analysis. Their median age was 12 months (range, 1–36). Criteria for UTI were fulfilled in 51 (15%). A malodorous urine was reported by parents in 57% of children with UTI and in 32% of children without UTI. On logistic regression, malodorous urine was associated with UTI (odds ratio 2.83, 95% confidence interval: 1.54–5.20). This association remained statistically significant when adjusted for gender and the presence of vesicoureteral reflux (odds ratio 2.73, 95% confidence interval: 1.46–5.08).

CONCLUSIONS: Parental reporting of malodorous urine increases the probability of UTI among young children being evaluated for suspected UTI. However, this association is not strong enough to definitely rule in or out a diagnosis of UTI. Pediatrics 2012;129:885–890

WHAT'S KNOWN ON THIS SUBJECT: The presence of malodorous urine is often mentioned as one of the clinical manifestations of urinary tract infection (UTI) in young children, yet the few studies looking at this symptom are contradictory.

WHAT THIS STUDY ADDS: Our study demonstrates that malodorous urine as reported by parents increases the likelihood of UTI among young children evaluated for suspected UTI. However, this association is not strong enough to definitely rule in or out a diagnosis of UTI.

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KEY WORDS
urinary tract infection, child, odor, urine

ABBREVIATIONS
CI — confidence interval
ED — emergency department
FWS — fever without source
OR — odds ratio
UTI — urinary tract infection
VUR — vesicoureteral reflux

All authors contributed substantially to the conception and design of the study; Dr Gravel performed the data analysis, and all authors were involved in the interpretation of the data; Dr Gauthier prepared the first draft of the manuscript; and all the authors participated in revising the article, and approved the final version of the manuscript.

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Urinary tract infection (UTI) occurs in ∼8% of girls and 2% of boys by the age of 7 years. Acute pyelonephritis is the most common serious bacterial infection in childhood. In younger children, fever without source (FWS) is often the mode of presentation of UTI. The lack of more specific symptoms or signs may delay the diagnosis in this age group. Moreover, appropriate methods to obtain urine culture in young children, namely suprapubic aspiration and bladder catheterization, are invasive and should be ordered with care. There is some debate as to the timing and extent of investigations in this population. Any additional clinical clue, with sufficient predictive ability, could help practitioners decide when to evaluate a young child for a possible UTI.

Malodorous urine has been reported in 2% to 18% of children with UTI and is often described in review articles as 1 of the clinical manifestations of UTI in young children. However, 14% of parents asked to answer a questionnaire on teething symptoms described malodorous urine as associated with teething. So far, only a few authors have studied the value of malodorous urine as a predictor of UTI. Their results are contradictory.

Shaw et al described higher prevalence of UTI in young children with FWS having malodorous urine or hematuria. Couture et al found foul-smelling urine as 1 of 4 variables enabling prediction of UTI in children <2 years of age, whereas Struthers et al did not find any association between parental reporting of a particular urine smell and a diagnosis of UTI in children <6 years of age. The objective of this study was to determine whether parental reporting of malodorous urine is associated with UTI in young children.

METHODS

Study Design and Subjects

We conducted a prospective cohort study in the emergency department (ED) of a pediatric university-affiliated tertiary-care center (Sainte-Justine University Hospital Center, Montreal, Canada) from July 31, 2009 to April 30, 2011. This center has an annual ED census of ∼60,000 patient-visits.

All children aged between 1 and 36 months for whom a urine culture was prescribed for suspected UTI (ie, FWS, unexplained irritability, or vomiting) by the treating ED physician were assessed for eligibility. Fever was considered present if parents reported fever at home or if, in the ED, the child’s body temperature was >38.5°C rectally. Exclusion criteria included antibiotics other than for prophylaxis given over the preceding 48 hours, diabetes or other metabolic disease, vesico/ureterostomy or urinary catheter in place, patient already included in the study, person accompanying the child not knowing the patient well enough to answer the questionnaire (see below), and inability to administer the questionnaire in either English or French.

Patients were recruited during the weekdays (Monday to Friday) from 10:00 AM to 6:00 PM. For all eligible patients, a standardized questionnaire was administered to the parents (or to the person accompanying the child) by a research assistant. The questionnaire was administered as soon as the urine culture was prescribed and before the result of the urine analysis was communicated to either the parents, the research assistant, or the physician. It was available in both English and French. The first part consisted of questions on past medical history (history of UTI and vesicoureteral reflux [VUR], circumcision status), administration of antibiotics (prophylactic or not) over the last 48 hours, and the duration of fever, if present. The second part included 8 questions on symptoms presented by the child during the 48 hours before the ED visit (see Table 1). For 7 of these questions, the response was either yes or no. If the respondent was unable to answer, the response was considered negative. The eighth question requested the number of episodes of vomiting.

Data obtained from the questionnaire were collected on standardized data collection forms by the research assistant. Demographic data, why the urine culture was prescribed, and the results of laboratory tests performed in the ED were retrieved through review of medical records by the research assistant and collected on the same forms. According to the study protocol, there were 3 possible reasons to prescribe a urine culture for suspected UTI: FWS, unexplained vomiting without fever, or irritability in an afebrile child. In the case of a child who presented with vomiting or irritability, and who was also febrile, FWS was considered to be the reason for urine sampling. Laboratory tests were ordered according to the clinical judgment of the ED physician. Results of urine cultures were collected a posteriori from the patient’s chart by the principal investigator (M.G.) blinded to the exposure of interest. In the event where 2 urine cultures were performed either by midstream voiding or bladder catheterization, and the results were different from each other, the urine culture with the lower bacterial count was considered as the final result for the patient concerned.

<table>
<thead>
<tr>
<th>Table 1 Questions Asked on Symptoms Presented by the Child</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Has your child vomited?</td>
</tr>
<tr>
<td>2. If your child vomited, how often did this happen?</td>
</tr>
<tr>
<td>3. Has your child had diarrhea (liquid stools or stools much softer than usual)?</td>
</tr>
<tr>
<td>4. Have you had the impression that your child had a stomachache?</td>
</tr>
<tr>
<td>5. Have you had the impression that it was difficult for your child to pee?</td>
</tr>
<tr>
<td>6. Have you had the impression that it was painful for your child to pee?</td>
</tr>
<tr>
<td>7. Have you noticed that your child’s urine smelled stronger than usual?</td>
</tr>
<tr>
<td>8. Have you noticed that your child’s urine smelled offensive?</td>
</tr>
</tbody>
</table>
Collection of urine specimens was done as usual by the ED nurses. The method of sampling was decided by the ED physician. Patients for whom urine culture was collected by bag were excluded a posteriori.

The primary independent variable of interest was the presence of malodorous urine as defined by urine that smelled stronger and/or more offensive, according to the parents. The primary outcome was a UTI defined as: $\geq 50 \times 10^6/L$ of a single identified pathogen in urine culture obtained through bladder catheterization (excluding lactobacilli, corynebacteria, and coagulase-negative staphylococci); urine cultures were also considered positive if they revealed $\geq 10 \times 10^6/L$ of *Pseudomonas* species; $\geq 100 \times 10^6$ bacteria/L of a single identified pathogen in urine culture collected from clean-catch or midstream void (excluding lactobacilli, corynebacteria, and coagulase-negative staphylococci); or any amount of Gram-negative bacteria in urine culture obtained from suprapubic aspiration (or $\geq 10 \times 10^6$ of Gram-positive bacteria/L). Patients with a urine culture not meeting these criteria were considered to not have a UTI.

### Human Subjects Protection

This study received full approval from Sainte-Justine University Hospital Center's Institutional Review Board. To participate in the study, parents had to provide written informed consent for their child. To prevent bias in answering the questionnaire, the study was entitled “Predictive factors of UTI in 1- to 36 month-old children” on the consent form, and parents were asked to participate in a research project that aimed to describe certain symptoms that could predict a UTI in 1- to 36-month-old children, without being more specific.

### Data Analysis

All data were entered in an Excel database (Microsoft Inc, Richmond, WA) and were analyzed with SPSS version 17 (SPSS Inc, Rainbow Technologies). The 95% confidence intervals (CI) were measured for all comparisons. Baseline characteristics were measured for those children included and excluded in the final analysis. Clinical characteristics including the presence/absence of malodorous urine were also measured for children with and without UTI. The primary analysis of interest was the association between parental reporting of malodorous urine and UTI by using logistic regression analysis. Simple logistic regression was used to evaluate other potential predictors of UTI (gender, age, past medical history of UTI, VUR, and other symptoms). In a second step, a multiple logistic regression analysis was performed to evaluate the predictive ability of malodorous urine adjusted for the predictors identified in the first step. To evaluate whether the model accurately predicted the outcome, a Hosmer-Lemeshow goodness-of-fit test was performed.

The sensitivity of the reporting of malodorous urine was measured by dividing the number of patients with malodorous urine and UTI by the total number of UTIs. The specificity was calculated by dividing the number of participants with no malodorous urine and no infection by the total number of patients with no infection. The positive and negative likelihood ratios were calculated. Finally, a secondary analysis was performed to evaluate the association between malodorous urine and markers that could be associated with the urine smell (nitrite, leukocyte esterase, ketone bodies, specific gravity).

### RESULTS

Of 601 participants originally screened, 396 were recruited over the study period (Fig 1). Sixty-five patients were excluded a posteriori, either because the urine culture, although prescribed, was not done, or was collected by bag, or showed gross contamination (polymicrobial flora). Three hundred thirty-one children were therefore included in the analysis.

Their baseline characteristics are described in Table 2. Their median age was 12 months, and 58% were female. FWS was the reason for suspecting UTI in $>90\%$ of cases. Urine cultures were performed through bladder catheterization in 297 (88%) children, through clean voiding/midstream in 31 (9%), and through suprapubic bladder aspiration in 3 (1%). The questionnaire was administered to the mother in 279 cases (84%), the father in 38 instances (12%), the 2 parents in 6 cases (2%), and people other than parents in 8 instances (2%).

UTI criteria were fulfilled in 51 children (15%) (Table 3). In these patients, the infection was suspected because of FWS; no UTI was found in afebrile children suspected of having this infection because of unexplained vomiting or irritability. Urine cultures were positive for *Escherichia coli* in 82% of cases (42/51).

A malodorous urine was reported by parents in 57% of children with UTI and 32% of children without UTI (Table 3). On simple logistic regression, this symptom was associated with the risk of UTI (odds ratio [OR] 2.83, 95% CI: 1.54–5.20). Other risk factors for UTI were female gender (OR 2.82, 95% CI: 1.41–5.61), and presence of VUR (OR 2.39, 95% CI: 1.04–5.53), whereas age and past medical history of UTI were not statistically associated with UTI. On multiple logistic regression, the association between malodorous urine and UTI remained statistically significant when adjusting for gender and presence of VUR (OR 2.73, 95% CI: 1.46–5.08). Malodorous urine showed a sensitivity of 0.57 (95% CI: 0.42–0.70) and a specificity of 0.68 (95% CI: 0.62–0.74) for UTI leading to a positive likelihood ratio of 1.79 (95% CI: 1.33–2.40) and a negative
likelihood ratio of 0.63 (95% CI: 0.23–0.45). The Hosmer-Lemeshow goodness-of-fit test suggested that the model fitted ($\chi^2$: 2.726; degrees of freedom 4; $P$ = .605).

Among symptoms commonly attributed to UTI looked at by the questionnaire (eg, vomiting, diarrhea, and dysuria), malodorous urine was the risk factor with the strongest association with UTI (Table 3). Finally, malodorous urine was more frequently observed in children whose urine analysis showed positive nitrite and leukocyte esterase on dipstick. There was no association between malodorous urine and presence of ketone bodies, high urine specific gravity, or urine pH (Table 4).

**DISCUSSION**

Our study showed that parental reporting of malodorous urine was associated with UTI in young children. The association between smelly urine and UTI was at least as significant as the association with female gender, past medical history of UTI, and presence of VUR. However, 40% of children with UTI in our series did not have malodorous urine and >30% of parents reported malodorous urine in children without UTI. Although parental reporting of malodorous urine increased the probability of UTI, in particular, in children with FWS, it did not have a sufficiently high specificity or sensitivity to definitively rule in or rule out a UTI. This is also the case for other symptoms considered as "classical" for this type of infection in older children, namely, flank pain or painful urination. Despite these limitations, and given the clear association between this symptom and UTI, reporting of malodorous urine by parents should make the clinician more suspicious of this type of infection in a young child with FWS. In our study, parents were asked specifically about the presence of malodorous urine and otherwise may not have reported it. The discrepancy between the rather low rate of smelly urine reported in previous studies in association with UTI in children (see above) and the rate in this study is probably explained by this observation. It could therefore be useful for the clinician to systematically ask about urine odor in children in whom UTI is suspected.

To date, 3 studies have reported the value of malodorous urine as predictor of UTI in young children. Results are contradictory, and, in these 3 articles, methodological flaws do not allow an accurate answer. The main objective of the first study was to establish prevalence of UTI in febrile infants <12 months and girls <2 years of age presenting to the ED with a fever “without a definite source.” Of the patients eligible for the study, 83% had a urine culture. The exact nature of the questionnaire administered was not described, nor if caregivers had previous knowledge of the urinalysis result when the questionnaire was administered. A history of

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**TABLE 2** Baseline Characteristics of Patients Recruited for the Study

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Included N = 531</th>
<th>Not Included* N = 65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median (range), mo</td>
<td>12 (1–36)</td>
<td>14 (1–35)</td>
</tr>
<tr>
<td>Weight, median (range), kg</td>
<td>9.7 (3.7–16.6)</td>
<td>10.45 (5.6–23.0)</td>
</tr>
<tr>
<td>Males, n (%)</td>
<td>142 (42)</td>
<td>40 (62)</td>
</tr>
<tr>
<td>Circumcision, n (%)</td>
<td>37 (26)</td>
<td>5 (13)</td>
</tr>
<tr>
<td>Past history of UTI, n (%)</td>
<td>62 (19)</td>
<td>7 (11)</td>
</tr>
<tr>
<td>VUR already identified, n (%)</td>
<td>32 (10)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Grade 3–5 VUR, n (%)</td>
<td>25 (8)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Antibiotic prophylaxis for VUR, n (%)</td>
<td>25 (8)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>FWS, n (%)</td>
<td>309 (93)</td>
<td>54 (83)</td>
</tr>
</tbody>
</table>

* Excluded a posteriori.
malodorous urine was noted in only 3% of UTI cases, which is a surprisingly low rate, given our own results. Higher prevalence of UTI occurred in those children with malodorous urine or hematuria, but the authors did not describe specific data for 1 or the other symptom. Couture et al confirmed performing a retrospective study of children <2 years of age suspected of having a UTI who had a urine culture collected during a 12-month period in a university-affiliated hospital. Ten percent (55/545) of urine cultures were positive. In this study, the method of urine collection was not described, and the presence of foul-smelling urine was assessed by chart review. It was present in 6.8% of children (37/545) and was identified as 1 of 4 predictors of UTI in their population. Struthers et al studied children aged <6 years who had urine collected routinely as part of their admission to hospital. Parents were asked to complete a questionnaire asking if their child's urine smelled differently from usual or had a specific smell. One hundred ten questionnaires and urine samples were collected. The authors did not state what proportion of parent samples were collected. The authors did not perform a parental history of UTI or VUR, nor did they state what proportion of parents had a diagnosis of UTI. However, in their study, malodorous urine was associated with the presence of nitrites and leukocyte esterase on the dipstick, but not with ketone bodies or specific gravity. This association between malodorous urine and nitrites/leukocyte esterase may be explained by the fact that nitrites and leukocyte esterase are, in themselves, good indicators for UTI, and the UTI itself causing the bad smell of the urine. Our study was not designed to identify what substance causes the urine to be malodorous in UTI. The smelly odor of infected urine may be due to the production of ammonia from urea split by bacterial ureases and may vary with certain bacteria.

There are some limitations to this study. First, there is no standardized definition of “malodorous urine.” Malodorous urine is a subjective description of odor. We chose to include 2 items in our definition, namely, a urine that smelled stronger and/or more offensive, according to the parents. Second, the presence of malodorous urine was not directly observed, but was considered present or absent according to parental opinion. However, if this clinical clue is to be used by clinicians, it will be obtained by questioning caregivers, as was the case in our study, more than by direct observation, which does not appear feasible. Third, we did not evaluate the predictability of malodorous urine for UTI in children seen in the ED at large, and, in particular, we did not include children brought to the ED for this symptom only, or for this symptom associated with dysuria but without fever. Indeed, to be valid, our study had to have a control group without the symptomatology (so without malodorous urine) and all children had to have urine cultures collected with an appropriate technique, which is most often invasive in this age group.

### TABLE 3 Clinical Characteristics of Patients Included in the Final Analysis (N = 331)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>With UTI N = 51</th>
<th>Without UTI N = 280</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median (range), mo</td>
<td>13 (2–36)</td>
<td>12 (1–36)</td>
<td>.182</td>
</tr>
<tr>
<td>Wt, median (range), kg</td>
<td>9.1 (3.8–16.5)</td>
<td>9.8 (3.7–15.8)</td>
<td>.125</td>
</tr>
<tr>
<td>Males, n (%)</td>
<td>12 (23)</td>
<td>130 (46)</td>
<td>.002</td>
</tr>
<tr>
<td>Circumcision, n (%)</td>
<td>0</td>
<td>37 (23)</td>
<td>.065</td>
</tr>
<tr>
<td>Past history of UTI, n (%)</td>
<td>13 (27)</td>
<td>49 (18)</td>
<td>.179</td>
</tr>
<tr>
<td>VUR already identified, n (%)</td>
<td>9 (18)</td>
<td>27 (8)</td>
<td>.036</td>
</tr>
<tr>
<td>Grade 3–5 VUR, n (%)</td>
<td>9 (18)</td>
<td>17 (6)</td>
<td>.017</td>
</tr>
<tr>
<td>Antibiotic prophylaxis for VUR, n (%)</td>
<td>7 (14)</td>
<td>18 (6)</td>
<td>.07</td>
</tr>
<tr>
<td>Presence of fever, n (%)</td>
<td>51 (100)</td>
<td>258 (92)</td>
<td>.038</td>
</tr>
<tr>
<td>Duration of fever ≥72 h, n (%)</td>
<td>25 (49)</td>
<td>100 (56)</td>
<td>.072</td>
</tr>
</tbody>
</table>

### TABLE 4 Association Between Smelly Urine and Results of Urine Analysis (N = 328)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Smelly Urine N = 117</th>
<th>Nonsmelly Urine N = 211</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of ketone bodies, n (%)</td>
<td>35 (30)</td>
<td>60 (28)</td>
<td>.777</td>
</tr>
<tr>
<td>Ketone bodies ≥3.9 mmol/L, n (%)</td>
<td>16 (14)</td>
<td>22 (10)</td>
<td>.380</td>
</tr>
<tr>
<td>Nitrite, n (%)</td>
<td>11 (9)</td>
<td>8 (4)</td>
<td>.037</td>
</tr>
<tr>
<td>Leukocyte esterase, n (%)</td>
<td>26 (22)</td>
<td>25 (12)</td>
<td>.013</td>
</tr>
<tr>
<td>Specific gravity ≥1.025, n (%)</td>
<td>31 (27)</td>
<td>60 (28)</td>
<td>.767</td>
</tr>
<tr>
<td>pH ≥7, n (%)</td>
<td>31 (27)</td>
<td>47 (22)</td>
<td>.390</td>
</tr>
</tbody>
</table>

* No urine analysis was available in 3 patients.

* By using a Pearson χ² test.
We considered that it was not ethically possible to obtain proper urine cultures in all patients included in a control group without malodorous urine, and with no clinical manifestations like FWS that would necessitate per se a urine culture. Fourth, it is possible that the presence of malodorous urine was reported spontaneously by some parents to the ED physician and initiated a urine culture. Fifth, our study involved only 51 children with UTI. This low number limits the possibility of secondary analysis for afebrile children suspected of UTI because of unexplained vomiting or irritability, and for children aged between 1 and 3 months of age. It was therefore not possible to describe the predictability of malodorous urine in these 2 subgroups of patients.

CONCLUSIONS

Parental reporting of malodorous urine is associated with UTI in young children. Although it increases the probability of UTI, in particular, in children with FWS, it does not have a sufficiently high specificity or sensitivity to definitely rule in or out a diagnosis of UTI. However, it should make the clinician more suspicious of this type of infection in a young child with FWS. In a child >3 months, it should encourage the physician to ask for a urine culture more rapidly than if the child had not had this symptom. In future, a clinical decision rule for UTI, incorporating malodorous urine, could be developed and validated prospectively to verify if this more accurately predicts UTI than the decision rules already reported.

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