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ORIGINAL ARTICLES

Urine culture from bag specimens in young children: Are the risks too high?

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Objective: To compare the risks of contaminated culture results and consequent adverse clinical outcomes in urine specimens obtained by

“clean-voided” bag method versus catheterization.

Study design: Hospital-based cohort study of all children ≤ 24 months with outpatient urine cultures (n = 7584) obtained from January 1993 to December 1995. Medical records were followed up for all children with contaminated culture results who had 1 or more additional cultures within 7 days of the original culture. Contamination rates of bag urine cultures from the emergency department and a pediatric test center were compared. Results: Contamination rates were 62.8% and 9.1% (P < .001) in bag versus catheter specimens, respectively. Contamination rates of bag urine specimens collected in the emergency department and pediatric test center were 56.4% versus 69.25%, respectively. Of the 3440 contaminated urines, 132 (1.7%) resulted in 1 or more adverse clinical outcomes. Adjusted odds ratios (and 95% CI) for these outcomes in bag versus catheter specimens were as follows: 4.9 (2.3 to 10.5) for unnecessary recall, infinite for delayed diagnosis and treatment, 4.8 (1.8 to 12.4) for unnecessary treatment, 15.6 (2.1 to 116.8) for unnecessary prolonged treatment, 4.1 (1.4 to 12.1) for unnecessary radiologic investigation, and 12.4 (1.6 to 95.5) for unnecessary hospital admission.

Conclusions: The risks of the “noninvasive” bag urine culture appear to exceed its benefits. (J Pediatr 2000;137:221-6)

ED

Emergency department

PTC

Pediatric test center
UTI
Urinary tract infection

Urinary tract infection is a common cause of fever in children <2 years of age. Among febrile children in this age group, the prevalence is

approximately 5%.[1] [7] Because of the high prevalence, the nonspecific nature of the clinical presentation, and the potential risks from delayed diagnosis or misdiagnosis in this age group, clinicians often obtain a sample of urine for analysis and culture.[8] [17] Available collection methods include clean-voided bag collection, suprapubic aspiration, and catheterization, each with its own advantages and disadvantages.[18] [29] The American Academy of Pediatrics Subcommittee practice parameters for the diagnosis of urinary tract infections in febrile infants and young children indicated the problems associated with urine specimens collected by bag technique.[28] The noninvasive bag sample is often seen as the most attractive option for nurses, physicians, and parents despite the well-known risk (30% to 70%) of obtaining a contaminated result on urine culture.[26] [27]

To our knowledge previous investigators have not examined the extent to which such contaminated culture results lead to adverse clinical consequences. We therefore undertook a study with 2 objectives: (1) to compare the frequency of adverse clinical outcomes based on decisions made from urine cultures obtained from bag versus catheter urine specimens and (2) to compare the contamination rates in bag urine cultures when the specimens are collected by trained laboratory technicians working in a specialized pediatric test center versus those collected by nurses working in a busy emergency department.

Methods

We designed a hospital-based cohort study of all children ≤ 24 months of age who had a urine culture obtained by clean-voided bag or catheterization in the ED or PTC of the Montreal Children's Hospital between January 1993 and December 31, 1995. The ED has 85,000 visits per year. The PTC is a specialized outpatient unit within the hospital where blood and urine specimens are procured. Our study comprised 7584 urine cultures obtained in 4632 different children.

Bag urine cultures were obtained by the application of a self-adhesive plastic bag (U-Bag Urine Specimen Collector by Hollister) after the perineum was cleaned (including penile foreskin and glans) with (antibacterial) green soap and thorough rinsing with tap water. Bags were placed by pediatric nurses in the ED and by trained medical technologists in the PTC. In the PTC the bag is routinely replaced every 30 minutes if the child has not voided; the bag is not routinely replaced in the ED. Catheter specimens were obtained

only in the ED with sterile technique after cleansing was done with iodinated soap and sterile water.

All urine culture results were obtained in chronologic sequence from a computerized log in the Microbiology Department and were classified as follows: negative, if there were <10³ organisms per milliliter in a bag specimen or <10² organisms per milliliter in a catheter specimen; positive, when a single organism was cultured at a concentration of ≥10⁴ organisms per milliliter in a bag specimen or ≥10³ organisms per milliliter in a catheter specimen; or contaminated, when 2 or more organisms were cultured or when a single organism was cultured in a concentration intermediate between that of a positive and negative result. Clinicians and researchers have variable criteria for colony counts that they use to diagnose a urinary tract infection depending on the method of collection used to obtain the urine. The previously described criteria are consistent with the standards published in recent textbooks and published articles. [7] [29] [33] In addition to the culture results, additional data extracted from the computerized log included the child's age, sex, date of urine culture, site where the culture was obtained (ED or PTC), and the result of a dipstick leukocyte esterase test for white blood cells as performed by the Microbiology Laboratory technician at the time the urine is received. The latter test result is available to the ED physician only at the time the urine culture result is available. The physician's decision to treat the patient before the culture result is reported is based on the clinical state of the child and the results of his or her own urinalysis done at the time of the ED visit. The latter results are not consistently recorded on the ED chart.

For all children with contaminated cultures, the Microbiology Laboratory log was searched for a record of 1 or more follow-up cultures obtained within 7 days of the original culture. For all children who had a follow-up culture, adverse clinical outcomes were assessed from the medical record. These outcomes were defined a priori and included unnecessary recall to the hospital for repeat urine culture, for which the result was negative or resulted in no change in clinical management; delayed diagnosis and treatment of a true UTI, as determined by a positive result on the repeat urine culture and no treatment for a UTI given at the time of the initial culture; unnecessary treatment, defined as a negative result on a repeat urine culture obtained before treatment was begun; unnecessarily prolonged treatment such as initial treatment that was continued despite a negative result on follow-up culture; unnecessary radiologic investigation (a renal ultrasound, voiding cystourethrogram, intravenous pyelogram, or dimercaptosuccinic acid scan) performed without a confirmed UTI, for example, a contaminated or negative result was obtained on a repeat culture; and unnecessary hospital admission, defined as hospital admission with a negative result on repeat urine culture before treatment was begun, when the child's clinical condition alone would not have resulted in an admission to hospital.

Principal results are based on the urine culture (n = 7584) as the unit of analysis. Thus unless otherwise specified, all rates (proportions) for adverse clinical outcome use the number of total urine cultures as the denominator, not the number of children with contaminated culture results. We also analyzed our results, however, after restriction to the first urine culture per child to ensure the independence of the statistical units of

analysis. This secondary analysis was done to avoid biasing results by the fact that a child who had 1 previously contaminated urine would be more likely to have the same consequences of a second contaminated urine than contaminated specimens from 2 different children. Statistical tests included χ^2 -tests of differences in proportions for bivariate analyses and multiple logistic regression analysis. All statistical analyses were carried out with SAS-PC for Windows.

Results

Of the 7584 total urine cultures obtained, 42.1% were from infants <6 months of age, 25.9% were from infants between 6 and 11 months, and the remaining 31.9% were from children in their second year; 43.8% of the urine cultures were obtained in boys. The urine cultures were evenly divided among bag specimens obtained from the ED (n = 2597), bag specimens obtained from the PTC (n = 2530), and catheter specimens from the ED (n = 2457). The cultures were also evenly distributed over the 3 study years. The dipstick leukocyte-esterase test, performed by the Microbiology Laboratory at the time of the plating of the specimen, was positive in just >20% of the urine specimens.

Overall, 39.4% of the urine cultures yielded a negative result on culture, 15.2% were positive, and 45.4% were contaminated. The risk of contaminated culture results differed markedly according to method of urine culture, however. For the catheter specimens 67.1% were negative, 23.8% were positive, and 9.1% were contaminated, whereas the corresponding results for bag specimens were 26.2%, 11.1%, and 62.8% (P < .001). Contamination rates were higher in male patients, infants >12 months of age, and children with a negative leukocyte esterase test on urine dipstick. We were surprised to find that when we restricted our analysis to bag specimens, the rate of contamination was significantly (P < .001) higher in those specimens obtained in the PTC (69.2%) than those obtained in the ED (56.4%).

Because the vast majority of urine cultures obtained in the PTC are ordered by private office-based community pediatricians, data on clinical outcomes are incomplete for these cultures. All analyses for adverse clinical outcomes were therefore restricted to urine cultures obtained in the ED. All of the adverse clinical outcomes under study were significantly more common in urine specimens obtained by the bag technique (Table I).

Table I. Crude rates (%) of contamination and of adverse clinical outcomes according to specimen collection method and other study factors (ED only)

Study factor
Contamination
Unnecessary recall
Delayed diagnosis/ treatment
Unnecessary treatment
Prolonged treatment
Unnecessary radiologic investigation

Unnecessary admission

Collection method

Bag

56.4*

2.1*

0.9*

1.2*

1.0*

0.8*

0.5*

Catheter

9.0

0.3

0.00

0.2

0.04

0.2

0.04

Sex

Male

38.7*

1.2

0.6

0.4†

0.3

0.4

0.2

Female

29.2

1.3

0.4

1.0

0.7

0.6

0.4

Age

<12 mo

31.4*

1.1

0.5

0.6

0.3‡

0.5

0.4

12-24 mo

38.7

1.6

0.5

1.1

1.0

0.5

0.1

Leukocyte-

enterase test

Positive

32.3

3.1*

1.0‡

1.8*

2.0*

1.1‡

0.6

Negative

33.7

0.7

0.3

0.4

0.1

0.4

0.2

*P < .001.

† P < .05.

‡ P < .01.

The elevated risks of these outcomes appear entirely attributable to the high contamination rates associated with bag specimens rather than to differences in physicians' interpretations of the contaminated culture results, because the risks of all 6 adverse clinical outcomes were similar in contaminated bag and catheter specimens (data not shown).

Over the 3-year study period, there was a significant ($P < .001$ by χ^2 for linear trend) tendency for more of the urine culture specimens from the ED to be obtained by catheterization than by clean-voided bag. The corresponding rates for catheterization in the 3 years were 38.9% in 1993, 54.9% in 1994, and 52.0% in 1995. After the analysis was restricted to urine cultures obtained in the ED, and after adjustment was done for the child's sex, age, leukocyte esterase test result, and year of study through multivariate logistic regression analysis, the risks of contamination and all of the adverse clinical outcomes remained significantly higher in bag urine culture specimens (Table II).

Table II. Adjusted* odds ratios (and 95% CIs) for contamination and adverse clinical outcomes associated with bag versus catheter specimens (ED only)

Outcome

Odds ratio (95% CI)

All urine cultures

First urine culture in each child

Contamination

13.3 (11.3-15.6)

13.6 (11.1-16.7)

Unnecessary recall

4.9 (2.3-10.5)

4.4 (1.5-13.0)

Delayed diagnosis and treatment

∞ †

∞ †

Unnecessary treatment

4.8 (1.8-12.4)

2.7 (0.9-8.3)

Prolonged treatment

15.6 (2.1-116.8)

9.9 (1.3-76.4)

Unnecessary radiologic investigation

4.1 (1.4-12.1)

2.2 (0.7-7.0)

Unnecessary admission

12.4 (1.6-95.5)

5.7 (0.7-48.4)

*Adjusted for child's age, sex, and leukocyte esterase test results.

† No cases of this outcome occurred with catheter specimens.

The results for contamination were unchanged when we restricted the analysis to the first urine culture obtained per child (to ensure independence of the statistical units of analysis), but the increased risks of the adverse clinical outcomes were somewhat reduced and, for several, no longer attained statistical significance.

Discussion

Contamination rates of urine samples collected in this study are in agreement with most[26] [29] but not all[34] reported studies. The fact that contamination rates were even higher in the PTC than in the ED suggests that improving the technique for preparing children for bag urine collection may not be effective in reducing those rates. Changing the cleansing agent to a bactericidal agent may reduce contamination but may also inhibit growth of a truly positive urine specimen. Given the fact that the data on urine collection were extracted from a computerized log, we have no specific information on the processing of urine specimens before they reached the laboratory. It is expected that the most optimal processing of the bag specimens would have taken place in the PTC, where our specimen collection and transport are least subject to variability. The fact that our results showed that bag specimens in the PTC were more likely to be contaminated than bag specimens from the ED suggests that improper processing of specimens does not explain our high contamination rates. The bag and catheter urine cultures are sent to a central laboratory for processing on a frequent basis and are routinely refrigerated as soon as they are obtained. There is no systematic process that

would account for a different delay in processing of bag versus catheter urines once these specimens are obtained.

Suprapubic aspiration is reported to have the lowest contamination rates and is acknowledged to be the gold standard for diagnosing UTI in children.[27] This technique, however, is considered too invasive by many nurses, physicians, and parents and is not a technique commonly used outside the neonatal period. When used in an ED setting, reported success rates in obtaining a urine specimen by suprapubic aspiration have been as low as 46% versus a 100% success rate with catheterization. [24] In many ill children the bladder may not be fully distended, which may explain the low success rate of suprapubic aspiration in this setting.

We have probably underestimated the rate of adverse clinical outcomes associated with bag versus catheter urine collection. If we had been able to perform follow-up on all children's contaminated urines both in the PTC and the ED (and not merely those children in the ED who had at least 1 follow-up urine culture in our hospital), it is likely that we would have detected an even higher rate. It seems unlikely, however, that the relative risks of adverse outcomes in catheter versus bag urines would be altered by inclusion of children who were monitored in an outside setting. Moreover, we did not study several additional potential adverse outcomes such as the emotional or economic aspects of unnecessary or prolonged treatment, investigation, admission, and recall to the ED and the medical consequences (eg, renal scarring, hypertension, or end-stage renal disease)[11] [17] of delayed diagnosis or treatment.

Catheterization of young children is perceived by some parents, physicians, and patients as invasive. The risks of adverse outcomes we have demonstrated must therefore be evaluated against the imagined and perceived risks of the catheterization procedure.[38] [40] Theoretically, catheterization could put the child at risk for UTI by introducing bacteria into the urethra or the bladder.[19] [24] Levin[41] reported a low risk of iatrogenic infection in adults after catheterization.[41] Lohr et al[42] reported an incidence of 10.8% hospital-acquired UTI in hospitalized children who had been catheterized (many with indwelling catheters),[42] but the relevance of this study to outpatient in-and-out catheterization of otherwise healthy children in an outpatient setting is questionable.

Caution is advised in generalizing the magnitude of risks we observed for adverse clinical outcomes associated with bag urine cultures. Patients, families, and physicians who have no previous knowledge of each other and who may never see each other again characterize our ED; a physician other than the one who obtained the initial urine culture often makes follow-up decisions. This is very different from a private office setting in which the physician is familiar with the child's history and has access to previous laboratory tests and is able to judge the likelihood that the child's parents will bring the child back, should the fever not resolve or new symptoms develop.

Based on our findings, we recommend that a catheterized urine sample be obtained in all febrile infants <3 months of age and in older febrile children who are not toilet-trained

but have other factors associated with a high risk of UTI such as toxic appearance, UTI symptoms, history of UTI, known renal anomalies, or urologic instrumentation. Non-toilet-trained children at lower risk should have a bag specimen for urinalysis and, if positive (as defined by >10 white blood cells per high powered field on an unspun urine specimen or a positive dipstick test for nitrite or leukocyte),[33] should then immediately have a catheter urine specimen sent for culture. Given the high rate of contamination and adverse clinical outcomes associated with bag urine cultures, we believe that bag urine specimens should not be sent for culture. In other words, despite its “noninvasive” reputation, the use of bag urine cultures appear to exceed its benefits.

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