Contamination rates of different urine collection methods for the diagnosis of urinary tract infections in young children: An observational cohort study

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Aims: The optimal method for diagnostic collection of urine in children is unclear. National Institute of Health and Clinical Excellence recommend specimens taken by clean catch urine (CCU) for identification of urinary tract infection (UTI). We investigated contamination rates for CCU, suprapubic aspiration (SPA), catheter specimen urine (CSU) and bag specimen urine (BSU) collections.

Method: Retrospective observational cohort study with review of microbiology data and medical records at a large tertiary children's hospital. We reviewed urine culture growth from consecutive first urine specimens of children aged <2 years, over a 3-month period in 2008. Patient demographics, collection method, location (emergency department, inpatient ward), culture growth, history of UTI, urogenital tract abnormality and antibiotic use were assessed. Contamination rates for collection methods were compared using logistic regression.

Results: Urine culture specimens of 599 children (mean age 7.0 months, 54% male) were included. There were 34% CCU, 16% CSU, 14% SPA, 2% BSU and 34% with unknown sample method. Contamination rates were 26% in CCU, 12% in CSU (odds ratio (OR) 0.4, 95% confidence interval (CI) 0.2–0.8) and 1% in SPA (OR 0.03 95% CI 0.0–0.3). Concurrent antibiotics use was associated with a lower contamination rate. Contamination rates were not associated with age, sex, location, history of UTI or urogenital abnormalities.

Conclusion: Contamination rates in CCU are much higher than in CSU and SPA samples. Ideally, SPA should be used for microbiological assessment of urine in young children. Collection procedures need to be optimised if CCU is used.

Key words: child; clean catch urine; emergency department; suprapubic aspiration; urinary tract infection.
Urine collection methods

S Tosif et al.

Urine collection methods

S Tosif et al.

Urine collection methods

S Tosif et al.

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S Tosif et al.
Outcome measures

Primary outcome measure was the contamination rate for each urine specimen collection method. We also sought to adjust for possible confounding factors by investigating the effect of age, gender, location, past history of UTI and urogenital abnormality, and antibiotic use at time of urine specimen collection.

Data analysis

Logistic regression was used to compare contamination rates between collection methods, using CCU as the comparator for odds ratios (ORs) as it is the recommended method in the NICE guideline. The effect of potential confounding from the variables listed previously was also examined. Statistical calculations were performed using Stata 11.0 (Stata Corp, College Station, TX, USA).

Results

We identified 818 urine samples sent for urine culture to the RCH microbiology laboratory from children under 24 months during the study period. Two hundred sixteen urine samples were excluded, as we sought only the first specimen from each child. One nephrostomy and two vesicostomy urine samples were also excluded. The study sample of 599 urine results was further analysed (Table 2). Fifty-four per cent were male. The age range of children was 0–23 months with a mean age of 7 months (male 8 months, female 6 months). The largest age group (215, 36%) were infants aged less than 3 months. Overall, most urine specimens were obtained by CCU (34%), followed by CSU and SPA. Relatively few urine specimens were obtained by BSU. For a high proportion of specimens, the collection method had not been recorded (34%). Most urine collections were obtained in the ED. ED collections were by CCU (39%), CSU (15%), SPA (16%), BSU (0%) and unknown (30%), whereas inpatient collections were by CCU (19%), CSU (23%), SPA (11%), BSU (4%) and unknown (42%). Urine collections were by SPA at 19, 13, 14 and 8% in children at <3, 3–6, 7–12 and 13–23 months, respectively.

The contamination rates of different methods of urine collection are shown in Table 2. Contamination rates were 26% in CCU versus 12% in CSU (OR 0.41 (0.21, 0.81) 0.01 and 1% in SPA (OR 0.03 (0.00, 0.26) <0.005. The few bag specimen samples showed a high rate of contamination (46%), and urine collected by an unspecified method had a contamination rate of 20%.

Analysis of additional patient variables is shown in Table 3. Of the 383 patients with urine samples collected by SPA, CCU or CSU, 369 medical records were available for review and 14 were unavailable. Five per cent of children in this subset had prior UTI, 14% were receiving antibiotics when the specimen had been obtained and 11% had a known urogenital abnormality. Only antibiotic use at the time of urine collection was associated with a differential, lower contamination rate (OR 0.18, 95% CI 0.04–0.75). Results by multivariable logistic regression when adjusted for age, gender, patient location and antibiotic use showed similar results (data not shown) as the unadjusted results shown in Table 2.

Discussion

This study is the first to provide ‘real-life’ comparative contamination rates of the three main methods of urine collection.
in children less than 2 years of age, and reflects the urine collection practices of a tertiary children’s hospital ED and inpatient setting. Our results indicate that the method of urine collection significantly affects contamination rates. As expected, bag urine specimens were found to have an acceptably high contamination rate of 46%. Although it is advocated as an appropriate collection method for children in the current NICE guideline, clean catch specimens were contaminated at a very high rate of 26%. CSU was contaminated in 12% and SPA with a low rate of 1%. There was no statistically significant effect observed with age, gender, location and history of previous UTI or urogenital tract abnormality on contamination rates. Use of antibiotics was associated with a lower contamination rate, which is likely due to residual antimicrobial activity that kills contaminant flora.

Table 3 Patient variables and effect on contamination, statistical analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total no. (%)</th>
<th>Contaminated no. (%)</th>
<th>OR (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past urinary tract infection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>349 (95)</td>
<td>59 (17)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>20 (5)</td>
<td>4 (20)</td>
<td>1.23 (0.40, 3.81)</td>
<td>0.72</td>
</tr>
<tr>
<td>Antibiotic used at time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>319 (86)</td>
<td>61 (19)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>50 (14)</td>
<td>2 (4)</td>
<td>0.18 (0.04, 0.75)</td>
<td>0.02</td>
</tr>
<tr>
<td>Urogenital abnormality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>329 (89)</td>
<td>57 (17)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>40 (11)</td>
<td>6 (15)</td>
<td>0.84 (0.34, 2.10)</td>
<td>0.71</td>
</tr>
</tbody>
</table>

CI, confidence interval; OR, odds ratio.

There are some limitations to this study. It did not include the clinical situation in which urine was collected, including the number of attempts required for urine collection or if one failed technique had preceded another. Because of the retrospective methodology, we were also unable to reliably extract the precise clinical indications for urine testing, which may have influenced collection method and technique. Data were not available about the use of urine dipstick tests as a method of pre-screening specimens by the treating clinician prior to being sent for culture that may have introduced bias.

Children thought to be at high risk for UTI may have been more likely to have urine collected by SPA, and some urine samples may have been sent to the microbiology laboratory even though the main purpose for collection was biochemical markers, which did not require a sterile sample. The retrospective design also did not allow an assessment of the clinician response to the results of contaminated specimens nor the consequences for the children concerned. In addition, a number of data points, such as history of UTIs or urogenital abnormalities, were dependent on the recording by the treating clinicians, and although we used a number of strategies for high quality chart review as set out by Gilbert et al., such as use of a piloted abstraction tool, repeat abstraction and repeat entry of a portion of records, the abstractors were not blinded to the purpose of the study.

However, the strength of our data in comparison with other smaller, prospective studies under research conditions is that it is potentially more likely to reflect real-life practice. Prior studies of contamination rates have been generally small scale, mainly obtained in controlled study settings. For example, the study referred to in the NICE guideline examining CCU contamination rates was a prospective study comparing CCU and BSU in inpatients in a UK hospital. Twenty-three urine samples by CVC were compared with 23 BSU. None of the CVC samples were contaminated with faecal bacteria, and 48% of BSU were contaminated. Given the controlled setting of this small study, there remain questions about contamination rates by CVC outside of a study environment.

There are highly variable contamination rates published in the literature, especially for CCU where rates have ranged from 0 to 85%. This is possibly due to variable collection methods and definitions for outcomes, making results difficult to compare between studies. While our data are based on practice by different medical and nursing practitioners of variable training, skills and experience using variable techniques at a large children’s hospital, they may reflect practice in other similar settings. Notably, the contamination rates for SPA in our study are similar to the low rates in other reports.

There is no definitive, universally accepted definition for what constitutes contamination. In this study, we have chosen to include as contamination only high CFU growths in urine cultures with multiple organisms. While growth of multiple pathogens is consistent with previously reported definitions of contamination, we did not include culture growths of low colony counts. Low colony counts can be associated with contamination or asymptomatic bacteriuria. By excluding low colony counts, we intended to only analyse urine samples most likely to represent true contamination.

Uncontaminated urine specimens are essential for the accurate diagnosis of UTI. Although non-invasive methods such as clean catch and bag specimen are often used due to clinician preferences and concerns of discomfort for the patient, urine cultures that are contaminated lead to uncertainty regarding which children to treat or investigate further. While acknowledging that the NICE guideline is mainly aimed at the primary care physician, the clinical dilemma of ambiguous urine culture results exists across all care settings, and the need for accurate samples is potentially more important where the child can not be observed...
over time. It has previously been demonstrated that SPA or CSU urine specimens can provide a definitive diagnosis of UTI.\textsuperscript{24–26} Our data suggest that in children under 24 months of age, the only technique for consistently obtaining uncontaminated urine is by SPA. We suggest that in settings where SPA can be conducted, for example, in EDs and in hospital settings, it should be preferentially used. In settings where this is not possible due to skills and resources (e.g. use of ultrasound to identify the bladder), the clean catch technique should be used only after clinicians and parents are educated about the optimal techniques.

There is, however, no standardised method for obtaining a CCU specimen and adherence to maintaining a sterile environment after cleaning the genital area is problematic. At the study hospital, the clinical practice guidelines states that the genitalia should be washed with water and dried and that the first few milliliters should be discarded.\textsuperscript{27} Data regarding the adherence to this guidance or quality of cleansing and maintaining a sterile environment are not known. These results suggest that further education on how CCU specimens and adherence to this guidance or quality of cleansing and maintaining a sterile environment are not known. These results suggest that further education on how CCU specimens are obtained is required, as previous studies have demonstrated reduced bacterial growth following cleansing of the perineum prior to clean catch,\textsuperscript{14} Repeat analysis of contamination rates with standardisation of collection techniques and training would add to this study.

Our results also identified a high rate of unrecorded methods of urine specimen collection, which is consistent with past audits of the recording of the methods used to collect urine specimens.\textsuperscript{28} This has a notable impact on laboratory culture media selection, cut-off values for contamination and diagnosis of UTI. One strategy to improve the recording of the method of collection would be that hospital laboratories refuse to process urine specimens without a specified method of collection clearly stated.

Conclusion

This study demonstrates an unacceptably high rate of contamination in urine culture from specimens obtained by CCU as compared with CSU and SPA in particular. While NICE UTI recommendations favour the use of CCU, our data indicate a potential for ambiguous results, need for repeat samples and potentially unnecessary treatment and investigation. Ideally, SPA should be used for microbiological assessment of urine in young children. The collection procedure needs to be optimised if clean catch is to be used.

Acknowledgement

We acknowledge grant support from the Murdoch Children’s Research Institute, Melbourne, Australia and the Victorian Government’s Operational Infrastructure Support Programme.

References

Urine collection methods


