Two-Step Process for ED UTI Screening in Febrile Young Children: Reducing Catheterization Rates

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Drs Blackstone, Lavelle, and Shaw conceptualized and designed the study, and drafted the initial manuscript; Ms Funari, Lopez, and Roper carried out improvement interventions and critically reviewed the manuscript; Dr Schast designed the data collection instruments and coordinated and supervised data collection; Ms Taylor and Voorhis carried out the initial analyses and reviewed and revised the manuscript; Ms Henien oversaw compliance with regulatory requirements for the study; and all authors approved the final manuscript as submitted.

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Acute pyelonephritis is currently the most common serious bacterial infection in childhood, yet it is difficult to detect on history or physical examination, as symptoms are nonspecific.1 In the nonverbal young child in diapers, fever is often the primary symptom and finding on examination.2 The risk of bacteremia outside the neonatal period is significant, with estimates as high as 3% in febrile children 2 to 24 months of age.3 Early detection and treatment with antibiotics relieves symptoms and progression of disease, as measured by nuclear renal scans at time of diagnosis and improvement in inflammatory markers after treatment.4 Although there is considerable uncertainty in the relationship between childhood urinary tract infection (UTI) and risk of end-stage renal failure based on data currently available,5 there is...
general agreement that diagnosis and treatment of UTI in febrile young children is important.

Screening for UTI can be painful, time-consuming, and costly. The 2011 guidelines from the American Academy of Pediatrics (AAP) support using predictive models to rationally determine which children should be tested, by using the evidence-based predictors of degree and duration of fever, gender, race, other potential sources for the child’s fever, and circumcision status. If a screening urinalysis or dipstick of fresh voided urine shows evidence of significant pyuria or bacteriuria, a culture should be sent. UTI is defined as having both pyuria or bacteriuria, a culture should be obtained by urethral catheterization or suprapubic bladder tap to avoid a high contamination rate. In the child who is not toilet trained, urine cultures should be obtained by urethral catheterization or suprapubic bladder tap to avoid a high contamination rate and patient morbidity.7 Thus, many emergency departments (ED) obtain urine for both screening and culture by urethral catheterization as a 1-step process to avoid wasted time, instead of a 2-step process of obtaining urine using a noninvasive urine bag first for screening and then by catheterizing only those who screen positive. Due to the predictive models’ higher sensitivity than specificity for screening,8 most urine samples will have a negative screen for pyuria or bacteriuria by urine dipstick or microscopy.9

Historically, at the Children’s Hospital of Philadelphia (CHOP), febrile children <24 months of age who were screened for UTI had urine obtained by urethral catheterization. Overall, 63% of febrile children in this age group were screened for UTI by urethral catheterization; screens were positive in only a small percentage of cases, with cultures positive in only 4.3%. Thus, many children were undergoing an unnecessary painful procedure. In this study, we sought to determine whether a protocol of screening for UTI with a correctly placed urine bag could feasibly be implemented in a busy ED, decreasing the need for urine catheterization without prolonging ED length of stay (LOS) or reducing detection of disease.

METHODS

Setting

This quality-improvement (QI) project was implemented at an urban, tertiary-care, pediatric academic ED with an annual volume of >90,000 patients, of which approximately 20% are aged 6 to 24 months. The ED is staffed by >50 different attending physicians, 300 rotating residents, 25 nurse practitioners, 150 nurses, and 25 technicians. On average, ~22% of patients 6 to 24 months of age seen annually present with a chief complaint of fever.

Planning the Intervention

Because of the previously described high catheterization usage rate coupled with a subsequent small rate of culture positivity, our overall aim was to reduce urethral catheterization rates in febrile children 6 to 24 months of age from a baseline of 63% to ≤30% through the adoption of a 2-step approach to screening febrile young children, starting with the noninvasive urine bag for urine collection.

Children 2 to 6 months of age were excluded from this intervention secondary to the concern for higher risk for bacteremia and false-negative urine screens in this age group.3,10,11 Additional exclusion criteria included known urinary tract abnormality, recent genitourinary surgery, immune deficiency, and neurogenic bladder. The project included a 6-month intervention period followed by 18 months of monitoring for sustainability. In accordance with institutional review board standards at our institution, this study was exempt from institutional review board review, as no subjects were randomized and no experimental data were collected.

The project was implemented over the course of 3 Plan-Do-Study-Act (PDSA) cycles (Table 1), beginning with a small test of the proposed change in an isolated urgent care area of the ED. Urgent care provides care for large numbers of low acuity patients (Emergency Severity Index 4, 5 patients) and is staffed by pediatricians, pediatric emergency medicine attending physicians, nurse practitioners, registered nurses, and technicians. All those scheduled to work in the urgent care area during the trial received direct education on the improvement project, and were subsequently asked to complete feedback forms for each patient for whom a urine bag was initiated for QI purposes. Staff education included face-to-face teaching on (1) the patient criteria for screening, (2) the reason for bag placement instead of immediate catheterization, (3) the procedure for bag placement, (4) the criteria for positive point-of-care urine, and (5) the indications for culture via catheterization. Staff members were also assigned a discipline-specific electronic learning module with posttest assessment.

Nurses placed urine bags for urine collection on all febrile children 6 to 24 months who met minimum criteria for screening (Table 2) and instructed parents to encourage oral fluid intake. Verbal scripts for staff discussion with parents/caregivers were developed and included information to encourage oral intake as well as instructions to alert the nurse when urine was present in the bag for prompt retrieval and screening (Fig 1). The urine bags were placed on arrival to the ED room, and not in triage, to ensure a fresh specimen. Reassessment for presence of urine occurred at 30-minute intervals to prevent urine loss, prolonged stay, and invalid specimen results. Parents were consistently provided with education and reminders regarding
oral hydration and communicating with staff when urine was in the bag. To ensure appropriate patients were being screened in a timely manner, care teams discussed patient risk factors and created patient-specific, appropriate plans, including catheterization for those patients who did not void or had contaminated or lost specimens due to bag failure.

A point-of-care urine dipstick was performed if indicated based on physician identification of UTI risk as outlined on the hospital’s febrile UTI pathway, which follows current AAP recommendations and other available evidence (Fig 2). If the urine screened positive (moderate or large leukocyte esterase or presence of nitrites on urine dipstick), the child then underwent urethral catheterization for sterile urine culture, as urine specimens obtained by urine bag have an unacceptably high contamination rate. Patients with positive dipstick results were started on prophylactic antibiotics initiated per ED pathway and patient outcomes and culture results were monitored closely through standard ED nurse practitioner follow-up practices.

Planning the Study of the Intervention

The QI team met weekly to review patient records for patients meeting the study criteria, to assess feedback from bedside nurses, and to monitor the study’s outcome and balancing measures. Screening for ED revisits and chart review of primary care follow-up for patients within the hospital’s care network were also regularly conducted to determine if patients were missed with the new protocol.
the electronic medical record and validated by the study team. Balancing measures included ED LOS and missed UTI (assessed via chart review). Time to bag placement, positive culture rate, and patient revisits to the ED also were tracked.

**Analysis**

A time-series design was used to study the impact of the 6-month intervention. Comparative data were available for 12 months before the start of the intervention and 18 months after completion of active interventions, for a total of 36 months of data for the primary outcome of catheterization rate in febrile children ages 6 to 24. The p-chart, a type of statistical process control chart using the binomial distribution, was used to assess the impact of improvement efforts with the following criteria used to determine positive special cause variation due to changes in the process: ≥8 values below the baseline mean or ≥6 values in a row steadily decreasing.12

**RESULTS**

Before the intervention, on average, 63% of febrile young children ages 6 to 24 months (n = 1,520) were screened for UTI by using urethral catheterization; none were screened by urine bag. During the 6-month intervention, a similar percentage (69%) of febrile young children ages 6 to 24 months (n = 828) were screened for UTI. However, the vast majority had a urine bag placed as the initial step. Only 16% continued to have urethral catheterization as the initial method for UTI screening, generally due to strong clinical indications for UTI, change in urine color or odor, concern for pain around urination, high fever, tachycardia, and/or past history of UTI. The remaining 14% who had urine catheterization did so to obtain a culture following a positive urine screen obtained via bag or occasionally for inability to obtain adequate urine specimen via bag. Thus, overall, urethral catheterization rates were reduced by more than half, from 63% to 30%, sparing >350 patients the painful catheterization procedure during the 6-month intervention.

Immediate positive results were seen in weekly reviews, with a decrease in catheterization rate to 55% within 2 weeks of implementing the project’s interventions. As clinicians rotated to other areas of the ED, there was unintentional early spread of the intervention noted, as catheterization rates began to decrease in areas outside of the pilot unit. With visible improvement during the 1-month urgent care trial, the project was expanded to include all ED care areas in month 2. The catheterization rate continued to drop before stabilizing in the third month of the intervention, as shown in Fig 3.

Although nurses were quick to adopt the bagged urine screening process, data review showed an opportunity to improve the timeliness of bag initiation. In PDSA 3, a visual cue entered in the electronic health record (EHR) was implemented in month 6 as a reminder to place a urine bag. With the addition of the prompt in the EHR, the median time from patient roomed to bag placement decreased from 76 minutes to 48 minutes in just 2 weeks.

The overall median LOS for febrile children ages 6 to 24 months was 12 minutes higher in the intervention period when compared with a similar baseline time period (Table 3). However, on further analysis, the median LOS for patients who had urine collected via bag was 276 minutes, the same as in the preintervention period. The all-cause revisit rate remained unchanged. Approximately 39% of patients during the intervention period were followed within the hospital’s care network. Chart review of these patients found no missed cases of UTI.

**DISCUSSION**

Through online education modules, staff meetings, printed and EHR reminders, family involvement, team review of weekly data, individual and group feedback, and nurse scripting, the ED was able to achieve our aim of reducing catheterization rates among febrile young children ages 6 to 24 months by half (from 63% to 30%) over a 6-month period with sustained results. More than 350 patients were spared a catheterization in the intervention period alone with no increase in ED LOS for patients screened via bag. Additionally, there was no increase in the revisit rate and no missed UTIs among those followed within the CHOP primary care network.

Although urine catheterization remains the gold standard in diagnosing UTIs, it is an invasive procedure that may be avoided in most patients who are being screened. Although a 2-step process is an option suggested by the AAP guidelines,4 there are insufficient data in the pediatric literature to suggest use and reliability of urine bag screening in this age group in the ED. This is the first report in the literature exploring this alternative but safe method for accurately screening children ages 6 to 24 months for a UTI in a pediatric ED setting.

Educating >600 staff in a large institution, including rotating residents and new staff, was a challenge. Successful implementation and maintenance of this new practice was attributed to educating permanent nursing, advance practice provider, and attending groups and providing timely feedback to staff. There was initially a significant opportunity cost but, once the 2-step process was adopted, it was...
more easily sustained as the time and resources required by urinary catheterization were reduced.

This study has several limitations. The QI project was limited to patients evaluated in a pediatric ED at a large, urban, tertiary-care center with relatively long LOSs. We anticipate this work could be easily spread to other similar settings, especially if bag placement were to occur earlier in the process. Although it was presumed that parents would prefer screening with a less-invasive procedure via urine bag placement to catheterization, patient satisfaction was not directly measured as part of the QI project. However, ED staff reported mostly positive feedback from families with children undergoing urine screening with bag placement. Overall LOS from arrival to discharge was measured as a balancing measure instead of room to discharge, due to concurrent changes in triage during the intervention period, which could potentially skew the results. Additionally, revisits and other potential unintended consequences of the study were monitored via weekly chart review; however, data were restricted to the hospital’s ED and primary care network. The costs of urine bag and catheterization supplies, and nursing time were not measured in this study but may be considered in future metrics.

CONCLUSIONS

A 2-step less invasive process for screening febrile children for UTI can be instituted and sustained in a high-volume ED without increasing LOS or missing cases of UTI. Given

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**TABLE 3** Preintervention and Intervention Statistics: Febrile Young Children 6 to 24 Months

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>% Screened for UTI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urine bag only</td>
<td>63</td>
<td>68</td>
</tr>
<tr>
<td>Urine bag then catheterization</td>
<td>0</td>
<td>39</td>
</tr>
<tr>
<td>Catheterization only</td>
<td>63</td>
<td>16</td>
</tr>
<tr>
<td>Culture positivity rate, %</td>
<td>4.3</td>
<td>4.4</td>
</tr>
<tr>
<td>Revisit rate, all cause, %</td>
<td>3.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Median ED LOS, min: arrival to discharge, Oct–Mar</td>
<td>276</td>
<td>288</td>
</tr>
</tbody>
</table>

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**FIGURE 3**

Catheterization rate by month.
a growing focus on value-based care, organizations should consider improving processes to reduce unnecessary use of catheterization. As this QI initiative focused on children ages 6 to 24 months, the next phase of this initiative will include determining how best to approach managing younger children, who currently are still screened via urine catheterization.

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**ABBREVIATIONS**

AAP: American Academy of Pediatrics  
CHOP: Children's Hospital of Philadelphia  
ED: emergency department  
EHR: electronic health record  
LOS: length of stay  
PDSA: Plan-Do-Study-Act  
QI: quality improvement  
UTI: urinary tract infection

**REFERENCES**

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