Urine Culture Follow-up and Antimicrobial Stewardship in a Pediatric Urgent Care Network

Dipanwita Saha, MD,[a] Jimisha Patel, MD,[a] Don Buckingham, MBOE,[b] David Thornton, PhD, DABCC,[c] Terry Barber, MD,[a] Joshua R. Watson, MD[a]

abstract

BACKGROUND AND OBJECTIVES: Empiric antibiotic therapy for presumed urinary tract infection (UTI) leads to unnecessary antibiotic exposure in many children whose urine culture results fail to confirm the diagnosis. The objective of this quality improvement study was to improve follow-up management of negative urine culture results in the off-campus urgent care network of Nationwide Children's Hospital to reduce inappropriate antibiotic exposure in children.

METHODS: A multidisciplinary task force developed and implemented a protocol for routine nurse and clinician follow-up of urine culture results, discontinuation of unnecessary antibiotics, and documentation in the electronic medical record. Monthly antibiotic discontinuation rates were tracked in empirically treated patients with negative urine culture results from July 2013 through December 2015. Statistical process control methods were used to track improvement over time. Fourteen-day return visits for UTIs were monitored as a balancing measure.

RESULTS: During the study period, 910 patients received empiric antibiotic therapy for UTIs but had a negative urine culture result. The antibiotic discontinuation rate increased from 4% to 84%, avoiding 3429 (40%) of 8648 antibiotic days prescribed. Among patients with discontinued antibiotics, none was diagnosed with a UTI within 14 days of the initial urgent care encounter.

CONCLUSIONS: Implementation of a standard protocol for urine culture follow-up and discontinuation of unnecessary antibiotics was both effective and safe in a high-volume pediatric urgent care network. Urine culture follow-up management is an essential opportunity for improved antimicrobial stewardship in the outpatient setting that will affect many patients by avoiding a substantial number of antibiotic days.

Acute urinary tract infection (UTI) is a common and potentially serious infection in children. The diagnosis of UTI is based on suggestive symptoms, pyuria, and positive urine culture results, but these results may take up to 48 hours to confirm infection. Physicians therefore frequently prescribe empiric antibiotics for a presumed UTI while awaiting the culture results. However, because UTI symptoms are often nonspecific and dipstick urinalysis lacks adequate specificity, empiric treatment leads to substantial antibiotic exposure in children that ultimately proves unnecessary.[1–6] In emergency department and urgent care (UC) settings, the lack of guaranteed patient follow-up may lower the threshold

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for providing empiric treatment and thus increase antibiotic overuse. In fact, a study of children discharged from the hospital from our emergency department with empiric antibiotic therapy for a presumed UTI found that only 51% had the diagnosis confirmed by pyuria and a positive urine culture result.[3] Overconsumption of antibiotics can lead to immediate and long-term consequences, including the development of *Clostridium difficile*–associated diarrhea, antibiotic-associated adverse events, and the emergence of multidrug-resistant bacteria.[7] Reducing inappropriate outpatient antibiotic use is a priority of national programs aimed at curbing the threat of antimicrobial resistance.[8,9]

In the off-campus UC network of Nationwide Children's Hospital (NCH), positive test results (including urine cultures) that require a change in patient management are routinely reviewed and acted on. Patients and caregivers are notified of the results and the recommended change in treatment. However, before the present quality improvement (QI) study was conducted, no consistent mechanism was in place to follow up on negative urine culture results and discontinue unnecessary antibiotic therapy. Therefore, the objective of our study was to develop and implement a protocol for follow-up management of negative urine culture results to reduce inappropriate antibiotic exposure in the NCH off-campus UC network. We chose to focus on improving urine culture follow-up rather than decreasing empiric prescriptions as an initial stewardship intervention for 2 main reasons: (1) there are no national guidelines for providing empiric therapy for presumed UTIs, except in febrile infants in whom prompt antibiotic treatment is recommended when a UTI is suspected[10]; and (2) urine culture follow-up and antibiotic discontinuation should be the standard of care in all settings because even appropriate and judicious empiric UTI therapy will result in unnecessary antibiotic exposure in some patients.

METHODS

Setting and Population

NCH is a 508-bed, tertiary care, freestanding academic children's hospital in Columbus, Ohio, with a network of off-campus UC centers in the greater Columbus area and neighboring smaller cities. There were 4 off-campus UC centers at the beginning of the baseline period in July 2013. A fifth UC center opened in May 2014, and a sixth opened in October 2014. The patient volume is large, with 98 067 total patient encounters in the 6 UC centers in 2015. Patients evaluated at any of the 6 UC centers were eligible for the QI study if they received empiric antibiotic therapy for a UTI and had a subsequent negative urine culture result. Patients were excluded if the antibiotic was prescribed for either of the following: (1) duration ≤3 days; or (2) a diagnosis other than or in addition to UTI, such as acute otitis media, streptococcal pharyngitis, or cellulitis. The culture result was considered negative if it yielded no organisms, <10 000 CFU/mL of any organism, or only mixed urethral/perineal flora. NCH's institutional review board determined that this QI study did not meet the definition of human participant research and did not require institutional review board review or consent.

Interventions

Planning for the QI study began in September 2013, when follow-up of negative urine culture results was discussed at an UC clinician meeting as a quality and stewardship opportunity. A multidisciplinary task force was subsequently formed and included UC and infectious diseases physicians, nurses, a laboratory technician, an information systems specialist, and an improvement science professional. The task force developed a key driver diagram with the aim of increasing the percent documentation from 4% to 85% of discontinued antibiotics for all patients with a negative urine culture result. The task force aimed to achieve the goal by October 2014 and sustain the improvement for 6 months. In January 2014, UC clinicians were educated on how to document discontinuation of antibiotics in the medications section of the electronic medical record (EMR) to ensure accurate medication reconciliation as well as to facilitate data collection for the study. The task force followed the Institute for Healthcare Improvement model targeted intervention in the form of Plan-Do-Study-Act cycles[11] and developed a protocol for urine culture follow-up and antibiotic discontinuation (Fig 1). The protocol standardized a process in which the following occurred: (1) a nurse reviews the urine culture result; (2) a negative result in a patient who received antibiotic treatment is forwarded to a clinician; (3) the clinician determines that antibiotic discontinuation is appropriate based on the clinical presentation and result; (4) a nurse notifies the patient/caregiver of the result and the recommendation to discontinue the antibiotic (if unable to reach by telephone after 2 attempts on consecutive days, a letter is sent); and (5) the clinician documents discontinuation of the antibiotic in the medications section of the EMR. The protocol was formally implemented in September 2014 by providing education to UC clinicians and nurses both in person and via e-mail.

After protocol implementation, periodic reminders were provided to both clinicians and nurses at regularly scheduled staff meetings

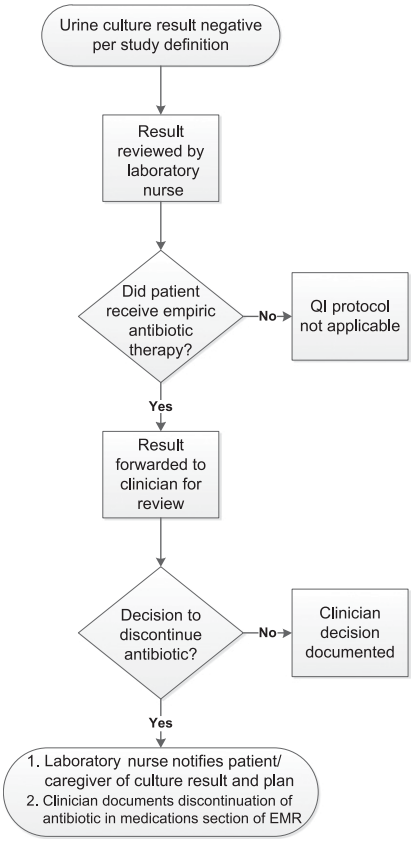

FIGURE 1
Flowchart of protocol for urine culture follow-up and antibiotic discontinuation.

and via e-mail. In September 2015, QI project boards were created and posted at each UC center to highlight center-specific data and progress. The project boards included key driver diagrams and control charts for 2 separate QI projects, 1 of which was the present UTI study. In addition, although not an intervention of the QI study, a process change occurred in the nursing review of laboratory results in January 2015 that affected the QI protocol. To improve the consistency of all laboratory results follow-up and to allow clinical nurses to focus on direct patient care, the off-campus UC network added a 0.7 full-time equivalent laboratory nurse position that consisted of one 4-hour shift 7 days per week. The laboratory nurse's responsibilities included follow up of all UC laboratory results and communication with clinicians and patients/caregivers regarding management of results. Neither the laboratory nurse position nor any of the QI interventions incurred financial costs directly related to the QI study.

Measures

Eligible UC encounters occurring from July 2013 through December 2015 were identified by searching the EMR for negative urine culture results. Data collection was limited to patients who were prescribed cefdinir, ciprofloxacin, nitrofurantoin, or trimethoprim/sulfamethoxazole because these antibiotics were the most commonly used during the study period. We determined the rate of antibiotic discontinuation in the medications section of the EMR within 48 hours of the finalized urine culture result. To assess the impact of the interventions on antibiotic exposure, the number of antibiotic days avoided each month was also determined. For each patient encounter, the difference between the prescribed days and the actual days of antibiotic therapy was calculated by using the start date, prescribed duration, and discontinued date in the EMR. In addition, encounters were reviewed in which the antibiotic was continued despite a negative urine culture result. Finally, as a balancing measure, subsequent UTI encounters at NCH were tracked that occurred within 14 days of the initial UC encounter from September 2014 (after implementation of the protocol) through December 2015.

Analysis

Monthly rates of antibiotic discontinuation were plotted by using statistical process control methods and a Shewhart p-chart (natural increments of discrete data from the target population).[12] This tool enabled us to define sequential process stage means, illustrating improvement over the course of the project. Calculation of control limits was based on process average and the subgroup size, with limits based on a binomial distribution of the data. We followed the Standards for Quality Improvement Reporting Excellence 2.0 guidelines in reporting this QI study.[13]

RESULTS

From July 2013 through December 2015, a total of 910 patient encounters met inclusion criteria. The rate of documented antibiotic discontinuation within 48 hours of the finalized urine culture result increased from a baseline mean of 4% to a mean of 84% (Fig 2). A total of 8648 days of antibiotics were prescribed in the 910 UC encounters. Urine culture follow-up and antibiotic discontinuation resulted in 3429 (40%) antibiotic days avoided (Fig 3). In 2015 alone, 1909 (61%) of 3142 prescribed antibiotic days were avoided.

Reasons for continued antibiotic use despite negative urine culture results fell into 4 categories: (1) the culture result was not reviewed by either a nurse or clinician; (2) the result was reviewed, but there was no documentation of any action taken, either to continue or discontinue the antibiotic; (3) the result was reviewed, but the clinician determined that the clinical scenario warranted continuation of the antibiotic despite the culture result; and (4) the clinician decided to discontinue the antibiotic, and the patient/caregiver was notified to do so, but the medications list in the EMR was not updated. Figure 4 displays the number and distribution of reasons for continued antibiotic use in 6-month intervals.

Of all patients whose antibiotics were discontinued from September 2014 through December 2015, a total of 46 returned to a NCH UC center, emergency department, clinic, or inpatient unit within 14 days of the

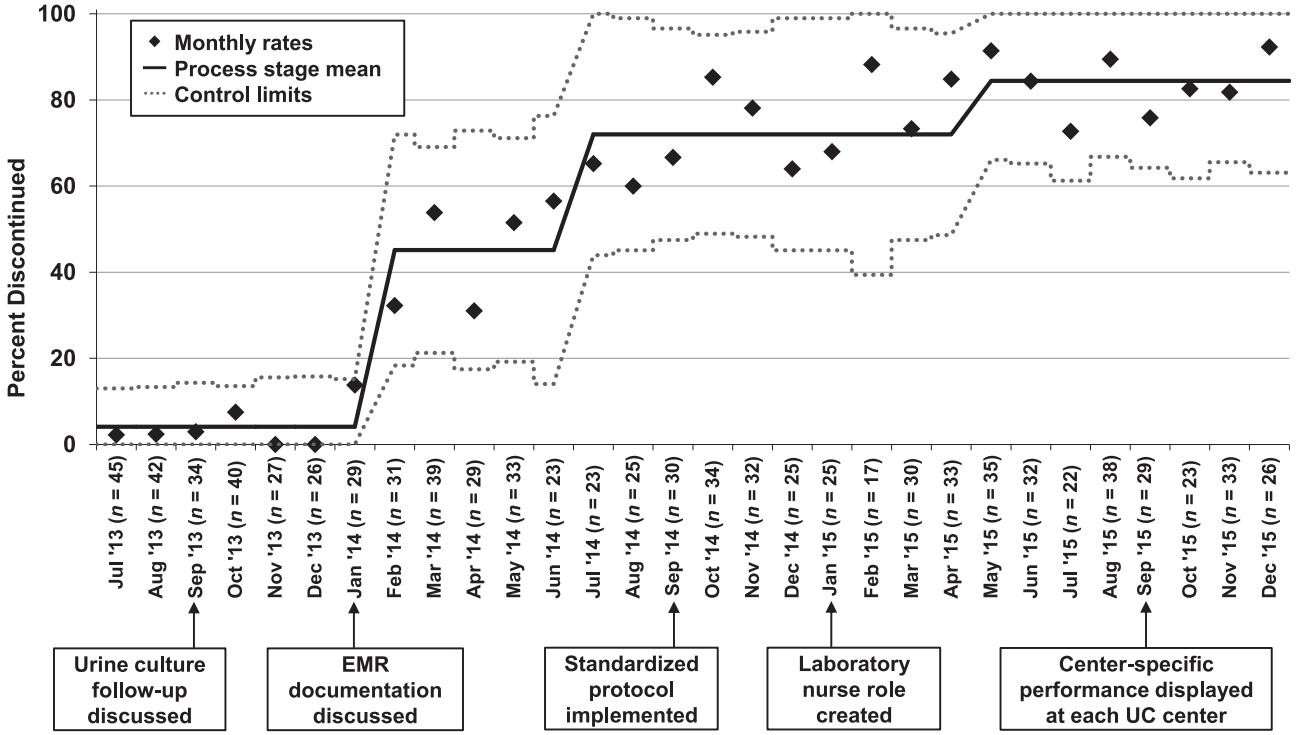

FIGURE 2
The Shewhart p-chart demonstrates the monthly antibiotic discontinuation rates for patients who were treated empirically for a UTI but had a negative urine culture result. Interventions are indicated below the chart with arrows designating the time each intervention occurred.

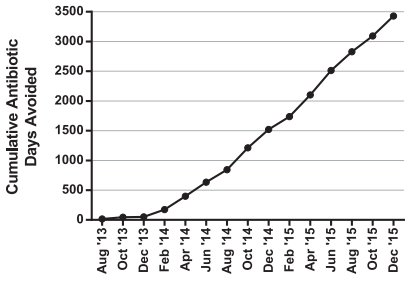

FIGURE 3
Cumulative antibiotic days avoided in 2-month intervals over the 30-month study period. For each patient encounter, antibiotic days avoided were calculated as the difference between the prescribed duration and the actual duration of antibiotic therapy documented in the medications section of the EMR.

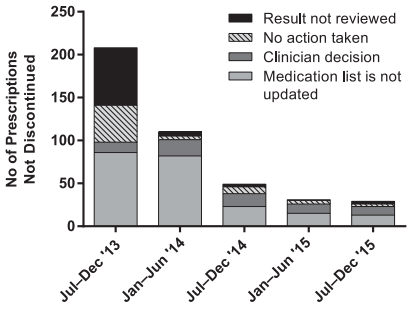

FIGURE 4
Reasons for continued use of antibiotics despite negative urine culture results, shown in 6-month intervals. The height of each bar indicates the total number of antibiotic prescriptions that were not discontinued in each 6-month interval, and shading indicates the contribution of each of the 4 categories.

initial UC encounter. No patient was diagnosed with a UTI at the return encounter.

DISCUSSION

Given the rising threat of antibiotic-resistant bacteria in the United States and throughout the world, increased attention to outpatient antimicrobial stewardship is urgently needed. To date, most outpatient stewardship efforts have focused on the management of acute respiratory tract infections or skin and soft tissue infections because they account for the majority of antibiotic prescriptions.[14–17] Although less common, UTIs nonetheless represent a major burden of health care utilization and antibiotic exposure in children.[18,19] In fact, antibiotics are prescribed for 70% of the ~1.5 million annual ambulatory UTI visits.[18] As such, empiric treatment of UTIs is an important target for stewardship. In the present QI study, we identified an opportunity to reduce unnecessary antibiotic days in these UC patients by implementing a protocol to follow up and act on negative urine culture results. Through a series of interventions, the antibiotic discontinuation rate was increased from 4% to 84% of relevant encounters, and ~3500 unnecessary antibiotic days were avoided over 30 months.

The data also indicate that our QI initiative was safe. During the 16 months that we tracked return visits, no patients were identified who were subsequently diagnosed with a UTI within 14 days of the initial UC encounter. The most likely reason for the absence of harm is that we chose a conservative

definition of a negative urine culture result. Only cultures with no growth, <10 000 CFU/mL of any organism, or mixed urethral/perineal flora alone were targeted because these results are unlikely to represent a UTI.[20] However, it is conceivable that some patients had a UTI with low growth in culture but were adequately treated before discontinuing the antibiotic. Most of our patients received 2 to 3 days of antibiotic therapy while awaiting results of the urine culture, a duration that may be as efficacious as longer treatment courses (7–14 days) for bacterial cystitis.[21,22]

Overall improvement in the antibiotic discontinuation rate indicated adherence to each step of the protocol, from initial review of the urine culture result by nursing staff to documentation of discontinuation of the antibiotic by a clinician in the medications list of the EMR. Even though follow up of urine culture results initially placed an added burden on clinical nurses, it was not a major barrier to implementation of the protocol, likely because the daily volume at each UC site was small. The addition of the laboratory nurse position relieved the clinical nurses of the follow-up responsibilities (ie, review of all UC laboratory results) but was not essential to the success of the study. In contrast, inconsistent documentation in the medications list of the EMR by clinicians was an important barrier to medication reconciliation and accurate data gathering. To address this problem, we discussed the importance of medication reconciliation at a clinician meeting in January 2014, followed by periodic e-mail reminders with screen shots outlining an efficient process for updating the medications list. We also demonstrated the process during clinician meetings. These measures resulted in substantial improvement; nevertheless, inconsistent documentation remained an ongoing barrier to success throughout the study period (Fig 4).

Our study has several limitations. First, we measured a process change but were unable to determine with certainty whether patients discontinued antibiotics when advised to do so. This limitation may serve to overestimate the impact of our intervention. Second, some patients/caregivers were advised to stop the antibiotic, but the clinician failed to document this advice in the medications section of the EMR (the study metric), which may underestimate the impact of the intervention. Third, our balancing measure captured only return visits to NCH sites. Of the 910 patient encounters, 878 (96%) had a medical home listed in the EMR, of which 23% were NCH primary care clinics. It is possible that some patients returned to primary care physicians outside the NCH network with a UTI after discontinuing the antibiotic. However, patients requiring hospitalization would likely have been referred to NCH because it is the only pediatric hospital in the Columbus metropolitan area. Finally, the results of our study may not be generalizable to all UC centers because it was performed in a large, academic UC network. Nevertheless, our interventions included basic education of providers, a simple and efficient protocol, and periodic feedback that could likely be implemented in many UC centers with no or minimal requirement for added resources or cost.

The planning process and successful implementation of our QI protocol resulted in several benefits beyond the main aim of the study. First, the QI protocol was subsequently implemented as standard procedure in the emergency department of NCH, thus improving stewardship among another large group of patients. Second, it created increased awareness among UC clinicians about the group's standard empiric management of possible/presumed UTIs and a desire to implement additional stewardship interventions. As a result, we discovered an overuse of broad-spectrum antibiotics for UTIs and unnecessarily long treatment durations for uncomplicated cystitis. A QI study aimed to optimize antibiotic choice and duration for UTI was recently initiated. In addition, increased attention to which patients receive empiric antibiotic therapy has sparked discussions about deferring empiric treatment while awaiting urine culture results in some patients at low risk for development of complications. We are currently gathering local data to inform these discussions and to develop specific criteria for when to treat empirically versus wait for culture results. Finally, the study improved patient education regarding the diagnosis and management of UTIs.

CONCLUSIONS

We used QI methods to implement a safe and effective protocol to follow up urine culture results and discontinue unnecessary empiric antibiotics in a high-volume pediatric UC network. Our results highlight an essential opportunity in outpatient settings to introduce quality and stewardship measures for UTI management that will affect many patients and avoid a substantial number of antibiotic days. Our study also led to additional efforts (an ongoing QI project) to increase the use of narrow-spectrum antibiotics for the shortest effective duration and to identify clinical scenarios in which it is appropriate to defer empiric antibiotic therapy pending urine culture results. Development of decision-support tools for empiric UTI management may serve to further reduce unnecessary antibiotic

exposure by guiding clinicians to prescribe antibiotics only for patients with a high likelihood of a UTI or high risk of complications.

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ABBREVIATIONS

EMR: electronic medical record
NCH: Nationwide Children's Hospital
QI: quality improvement
UC: urgent care
UTI: urinary tract infection

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