Improving a Urine Culture Callback Follow-up System in a Pediatric Emergency Department

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ABSTRACT

Introduction: Delays in appropriate treatment and unnecessary antibiotic use for urinary tract infections (UTIs) increase the risk for serious adverse events and the potential for antibiotic resistance. The purposes of this quality improvement project were to decrease emergency department laboratory result follow-up time and increase the number of patients who are notified to stop taking an empiric antibiotic.

Method: Nine months of Plan-Do-Study-Act (PDSA) cycles were implemented in a pediatric emergency department and network of care sites. Three months of baseline data were compared with 3 months of postinvention data using *t*-tests and odds ratios.

Results: Time to patient/family laboratory follow-up was reduced from 20.1 hours to 7.1 hours, demonstrating a 64.7% reduction in time to follow-up ($p < .01$). The percentage of patients who received follow-up notification of negative urine cultures and were told to discontinue antibiotic therapy increased from 8.8% to 74.4% ($p < .001$).

Discussion: Implementation of a culture callback system, staffed by advanced practice providers, led to a significant reduction in the amount of time to follow-up and increased the number of follow-up calls to discontinue antibiotics when urine cultures were negative. J Pediatr Health Care. (2015) *29*, 518-525.

KEY WORDS

Pediatrics, urinary tract infection, emergency medicine, quality improvement

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Conflicts of interest: None to report.

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0891-5245/$36.00

Published online July 21, 2015.

http://dx.doi.org/10.1016/j.pedhc.2015.06.003

Acute urinary tract infections (UTIs) are one of the most common bacterial infections in children and account for more than 1 million visits to pediatric offices annually (Freedman, 2007). Up to 8% of girls and 2% of boys will have at least one UTI by 7 years of age (National Institute of Diabetes and Digestive and Kidney Diseases [NIDDK], 2012). Although most pediatric UTIs are not serious, some infections can lead to pyelonephritis or other adverse outcomes.

It is often difficult to diagnose UTIs in infants and young children because of wide variation and nonspecific signs and symptoms. Fever, irritability, abdominal pain, and vomiting are all symptoms of a pediatric UTI that can be misinterpreted as an acute self-limited viral illness (American Academy of Pediatrics [AAP], 2011). The potential for misdiagnosis means that additional laboratory data are needed to differentiate a viral illness from a UTI. A urinalysis is indicated in any patient with UTI symptoms or a high fever (104°-105°F) without an

identified cause. Guidelines for pediatric UTIs presented by Bhat, Katy, and Place (2011) suggest that urine culture is the gold standard for diagnosing a pediatric UTI, and Schroeder and colleagues (2005) described merits of procedures to obtain urine for analysis and culture, recommending simply that UTI needs to be confirmed and it doesn't matter which method is used. A pediatric urine culture should be performed for any urine collected by urethral catheterization, when urinalysis results are equivocal, and when a urinalysis is highly suspicious for UTI (Bensman and Ulinski, 2009). Unfortunately, a urine culture can take up to 48 hours to confirm infection.

Patients with a confirmed UTI who are not treated in a timely fashion, or are treated with an inappropriate antibiotic, can have persistent symptoms or adverse outcomes that could include renal scarring, abscess, or other adverse outcomes (Kowalsky and Shah, 2013). The potential for these adverse outcomes make timely follow-up for urine cultures in children very important because appropriate antibiotic coverage—both empiric and after a culture is performed—can prevent present and future complications. A follow-up evaluation of the patient is necessary if (a) the child was not treated for a UTI and the urine culture result is positive, (b) the bacteria in the urine is resistant to the prescribed antibiotic, or (c) the child was treated with an antibiotic for a UTI and the urine culture is negative (AAP, 2011).

EVIDENCE

The AAP Subcommittee on Urinary Tract Infections Technical Report concluded that early evaluation and empiric antimicrobial treatment of UTI (within 24 to 48 hours of onset of fever) mitigates the risk of renal scarring (up to 50%) and that prompt treatment is warranted (Finnell, Carroll, & Downs, 2011). In addition, delaying treatment can cause serious effects. In children younger than 24 months who have a fever and a UTI, the chance of sepsis developing is about 10% (Oh et al., 2012). The authors concurred with the AAP Subcommittee recommendations in that a delay in treatment resulted in more renal scarring over time. Conversely, Larcombe (2010) performed a review and concluded that there was no convincing evidence that immediate empiric antibiotic treatment is more effective at preventing renal parenchymal damage when compared with treatment that is delayed up to 24 hours. Hewitt and colleagues (2008) found that a delay of 1 to 5 days posed no increased risk of renal scarring and no difference in scarring between infants and older children. However, the review by Larcombe (2010) also included randomized clinical trials that suggested a reduction in renal parenchymal damage in children treated immediately compared with those who had a delay in treatment of greater than 4 days of fever.

Thus some evidence shows that early treatment and efficient, timely follow-up of pediatric UTIs can prevent/reduce potential renal damage (Oh et al., 2012), and other research states that delaying treatment does not increase risks and adverse effects of UTIs if treatment is delayed 5 or fewer days. Many patients seek care for UTI symptoms after having fever and other UTI symptoms for several days. In addition, it takes up to 72 hours to obtain final results of urine cultures. Given that damage may occur during the first 4 to 5 days of symptoms, empiric treatment of UTI with timely follow-up is recommended as best practice by the AAP. Reducing the risk for harm and providing improved health care to patients is foundational to the purpose of this quality improvement project (QIP).

LOCAL PROBLEM

In the Emergency Department (ED) and Network of Care (NOC; i.e., urgent care and ED satellite) sites at Children's Hospital of Colorado (CHCO), physicians and advanced practice providers (APPs; i.e., nurse practitioners and physician assistants) are responsible for urine culture follow-up for patients who were seen and discharged home. Previously, urine culture follow-up was completed only by the provider in the ED if there was time during a busy clinical day. No single person was responsible for the laboratory follow-ups, which all too often included the ordering provider. Prior to this QIP, the average delay for culture follow-up from laboratory report to family contact was just over 20 hours. The initial data collected in this QIP showed that this follow-up to stop unnecessary use of antibiotics was occurring only 9% of the time. This substandard effort led to delays in appropriate treatment and unnecessary antibiotic use, increasing the risk for serious adverse events and the potential for increasing antibiotic resistance.

INTENDED IMPROVEMENT

The aim of this QIP was to improve the process by which urine culture follow-up occurs in a pediatric hospital emergency medicine department. Inconsistent UTI culture follow-up was responsible for delays in treatment, inappropriate antibiotic choice, and unnecessary antibiotic exposure, all of which were causes of concern for the medical director and staff of the ED. After discussions and a needs assessment, the quality improvement (QI) team developed the following study questions:

1. Can we decrease the average time to follow-up by centralizing the culture follow-up process?

We aimed to decrease the time to patient follow-up for urine cultures by 33%, from 20 hours (1203.19 minutes/patient) to 13 hours (434.94 minutes/patient) in 9 months.

2. How can we increase the number of patients who are called and informed they should discontinue antibiotic use when the urine culture is found to be negative?

We aimed to increase the number of negative urine culture follow-up calls to patients treated empirically with antibiotics at the time of their ED visit from 9% to 59% in 9 months.

METHODS

This QIP was conducted from January 2013 to March 2014. Preplanning began in January 2013 because this is the busiest time of the year for the ED and NOC sites, and it was deemed that successful interventions during this period were most likely to be lasting. Change processes followed procedures described by the Institute of Health Improvement (2003), and dissemination of findings followed Standards for Quality Improvement Reporting Excellence (SQUIRE) guidelines (Davidoff, Batalden, Stevens, Ogrinc, & Mooney, 2008).

Setting and Population

Data were collected from multiple CHCO sites in the metro Denver area, including the Main Campus ED in Aurora and all six NOC clinics located across the Denver metro area. The patient population included all children 0 to 21 years of age who were evaluated within the CHCO ED and NOC sites for symptoms of a UTI or when urine cultures were performed. Because this is a QIP, we did not note the individual patient age for persons with positive UCs, and thus we do not know the age range or median age of the patients during this study time period. The diagnosis of UTI, urine culture results, and UTI treatment were monitored in this QIP. Providers of care included physicians (with MD and DO degrees), pediatric nurse practitioners, family nurse practitioners, and physician assistants who are credentialed to practice at CHCO.

Interventions

Targeted interventions in the form of Plan-Do-Study-Act (PDSA) cycles were performed at different points during the project to address problems and areas of potential improvement (Tables 1 and 2). The ultimate goal of each intervention was to decrease time to follow-up and increase follow-up to discontinue antibiotic use in patients with negative urine cultures. Each cycle had pre- and postintervention data. This QIP was divided into the following periods:

- Q1 – Preintervention/baseline data (January–March 2013)
- Q2 – PDSA trials (April–June 2013)
- Q3 – PDSA trials (July–September 2013)
- Q4 – PDSA trials (October–December 2013)
- Q5 – Postintervention data (January–March 2014)

The first and biggest change in the follow-up process occurred when the "in basket" of laboratory results from the ED and NOC sites was made accessible to APPs. A designated daily, 2-hour culture call-back (CCB) shift was created with the intention that one APP would complete all of the follow-up calls each day (2 × 7 hours = 14 hours/week). We created this shift

TABLE 1. Reducing time to administration of antibiotics

PDSA	Time frame	Intervention/change
#1 Create 2-hour APP shift with training	March 28, 2013	Institute new process: A 2-hour shift for APPs was created to follow-up with urine cultures; the first 2 weeks of April, all shifts were performed by a small group of 4 providers; after that time and since, all providers in our group able to pick up these shifts Staff education: A 1-hour education session was provided at our monthly APP meeting at the end of March; all providers were welcome to attend the meeting; providers not allowed to perform the shifts without education—individual, group, or written
#2-1a E-prescribing	June 13, 2013 June 27, 2013	Institute e-prescription process: The EPIC EMR system has the ability to automatically fax prescriptions to local pharmacies; we partnered with the EMR specialist to enter fax numbers, addresses, and phone numbers Staff training: An E-prescribing workshop was provided at the June APP meeting; this is an optional improvement for those doing the follow-up shifts
#2-1b Update "pharmacy" data in triage	July 2013	Pharmacy preference question added at nursing triage: Nurses agreed to add to the routine triage, at all sites, a question about the pharmacy of preference (i.e., "If you need a prescription today, where would you like it called or faxed to?"); this also provides the ability to prescribe while on the phone with the family with the push of a button.
#3 Clinical care guidelines	October 2013	Clinical treatment and protocol approved: After 10 months and a few delays, the treatment and process guidelines were released to APP and medical staff; this process was delayed because of QI approval procedures at CHCO (Antibiotic Stewardship, Pharmacy Review, Infectious Disease Review, and QIT CHCO)
#4 Final review and updates	December 2013	Staff training, review: APP meeting with updates, training, review, questions, comments, or other follow-up needs

Note. *APP = Advanced practice providers; CHCO = Children's Hospital of Colorado; EMR = emergency medical record; PDSA = Plan-Do-Study-Act; QI = quality improvement; QIT = quality improvement team.*

TABLE 2. Calling patients with negative cultures

PDSA	Time frame	Intervention/change
#1 Create 2-hour APP shift with training	March 28, 2013	Institute new process: A 2-hour shift for APPs was created to follow-up with urine cultures; the first 2 weeks of April, all shifts were performed by a small group of 4 providers; after that time and since, all providers in our group are able to pick up these shifts Staff education: A 1-hour education session was provided at our monthly APP meeting at the end of March; all providers were welcome to attend the meeting; providers not allowed to perform the shifts without education—individual, group, or written
#2-2a Meeting updates and retraining	July 25, 2013 – staff meeting updates and review	Staff training: APP meeting to discuss in an open forum, answer questions, offer comments, and identify parts that could be performed better and any other problems; in addition, during the meeting a test was performed to show staff the correct procedure for performing a follow-up shift
#2-2b Individualized staff follow-up	August–September 2013	Data review by QIP team: During the monthly data review and calculations, it was very clear that 2 new providers who were performing the APP culture follow-up shifts were not calling families back to inform them to discontinue antibiotics; in the notes the culture was being identified as ''negative'' or ''contaminated,'' but the family was not called to discontinue antibiotics
	Mid–to-end September 2013	1:1 training with deficient providers: The 2 providers with deficiencies were each educated on the correct manner of performing follow-up shifts, including calling the families back and discontinuing antibiotics when urine cultures were contaminated or negative
#3 Clinical care guidelines	October 2013	Clinical care guidelines instituted: After 10 months and a few delays, the treatment and process guidelines were released to APP and medical staff; this process was delayed as a result of QI approval procedures at CHCO (Antibiotic Stewardship, Pharmacy Review, Infectious Disease Review, and QIT CHCO)
#4 Final meeting and updates	December 2013	Staff training, review: APP meeting with updates, training, review, questions, comments, and other follow-up needs

Note. *APP = Advanced practice providers; CHCO = Children's Hospital of Colorado; PDSA = Plan-Do-Study-Act; QI = quality improvement; QIP = quality improvement project; QIT = quality improvement team.*

by reducing 15 hours from the weekly APP schedule without the need of an additional provider or funding. Assigning a single person the responsibility for this task eliminated the previous haphazard approach to laboratory follow-up. Finally, time was made available to call patients with negative cultures to inform them to discontinue antibiotics when necessary.

Two interventions were key to success for time-to-follow-up in period Q3. First, the electronic medical record (EMR) specialist added an "E-prescribe" function (see Table 1, PDSA #2-1a), allowing the CCB provider to prescribe electronically through the EMR. Next, nurses recorded the patient's preferred pharmacy information into the EMR (see Table 2, PDSA #2-1b) in triage, which enabled all ED providers to relay prescription information to local pharmacies more efficiently. In period Q3, we offered a second training for staff who were improperly performing CCB shifts and presentation/discussions on proper CCB protocol in the monthly APP meeting (see Table 2, PDSA #2-2a/b).

In period Q4, clinical care guidelines were vetted and approved with the help of microbiology, infectious disease, and the ED (See Tables 1 and 2, PDSA #3). These clinical care guidelines assisted APP providers in distinguishing between positive and negative urine cultures, as well as at what levels cultures are determined to be contaminated. We held an open forum APP meeting to discuss treatment, comments, questions, or suggestions in December 2013 (see Tables 1 and 2, PDSA #4).

Data Collection

Data were collected for a total of 15 months from January 1, 2013, until March 31, 2014. International Classification of Diseases, 9th revision (ICD-9) codes for all UTIs and billing codes for all urine cultures for patients from 0 to 21 years at CHCO in the EDs and Urgent Care were used to identify patients. Data specific to this QIP were then drawn from the EMR for those patients. The list of patient names supplied by the Department of Informatics was destroyed as soon as the data were recorded anonymously. These de-identified data were organized in spreadsheets as monthly compilations to identify the following information: (a) if a urine culture was positive or negative from microbiology (yes or no); (b) if a urine culture was negative and treated as a UTI, was the patient or parent called to discontinue the antibiotic (yes or

no); (c) the time the laboratory result was received; (d) time of the first attempt at follow-up; and (e) minutes from the time the laboratory result was received to first follow-up. The data for urine cultures reflects all of 2013 and the first quarter of 2014. The project coordinator performed the analyses of the de-identified spreadsheets; personal health information and medical record numbers did not leave the hospital.

Data Analysis

Three-month benchmarking data from January through March 2013 was compared with January through March 2014. The data were collected from the same period each year because of census variation in the ED and NOC throughout the year. Data were entered into Vasserstats.net, an online software tool, and analyzed for statistical significance. A Student *t*-test was used to calculate significant differences before and after the intervention for time to follow-up (a continuous measure), and odds ratio was used to calculate differences in stopping unnecessary antibiotic use before and after implementation (categorical coding).

Ethical Issues

Patients were not recruited for the study, because this QIP is a study of systems process change. Risks to human subjects were deemed minimal, and the Colorado Multiple Institutional Review Board does not review QIPs because they are deemed "not research." However, this protocol was reviewed by a faculty department team and the College of Nursing faculty Bridge Committee to ensure QIP status.

RESULTS

More than 126,000 patients were served in CHCO ED and NOC sites in the year 2013. Of those, a urine culture was performed for roughly 5,200 patients (4.1%), resulting in about 400 urine cultures per month, with approximately 45 needing follow-up services as described in this QIP. Fifteen-month Six Sigma control charts for each aim detail the change over the course of the QIP (Figures 1 and 2).

Outcome of Aim 1: Reducing Time to Follow-Up

An independent, two-sample *t*-test was used to determine if there was a significant change in the time to patient follow-up for urine cultures. The time to patient follow-up for urine culture decreased significantly from 20.1 hours to 7.1 hours after QI implementation (mean change = 13.0; degree of freedom = 2.1; $t(2.07) = 19.17$; $p = .003$).

Outcome of Aim 2: Discontinuing Unnecessary Antibiotic Use in Patients With Negative Urine Cultures

The number of negative urine culture follow-up calls for patients treated empirically with antibiotics at the time of their ED visit improved from 8.8% to 74.4%. This increase was a statistically significant odds ratio

FIGURE 1. Average time to follow-up by month.

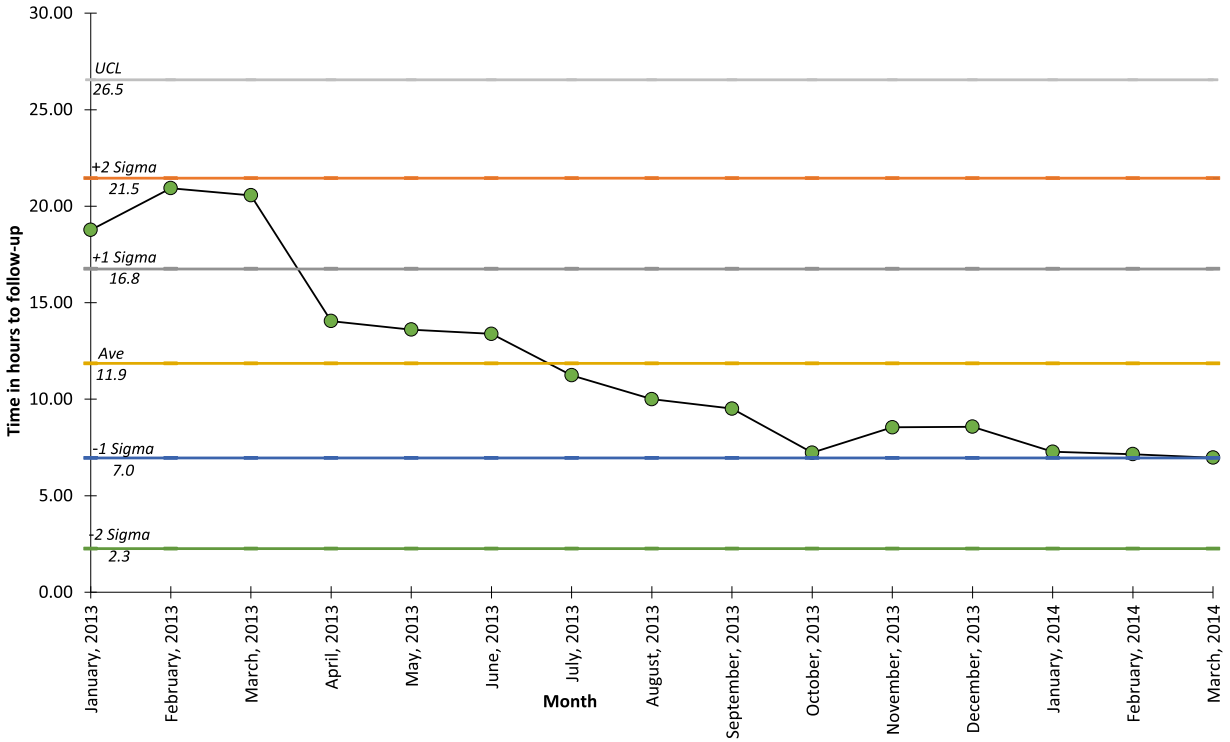

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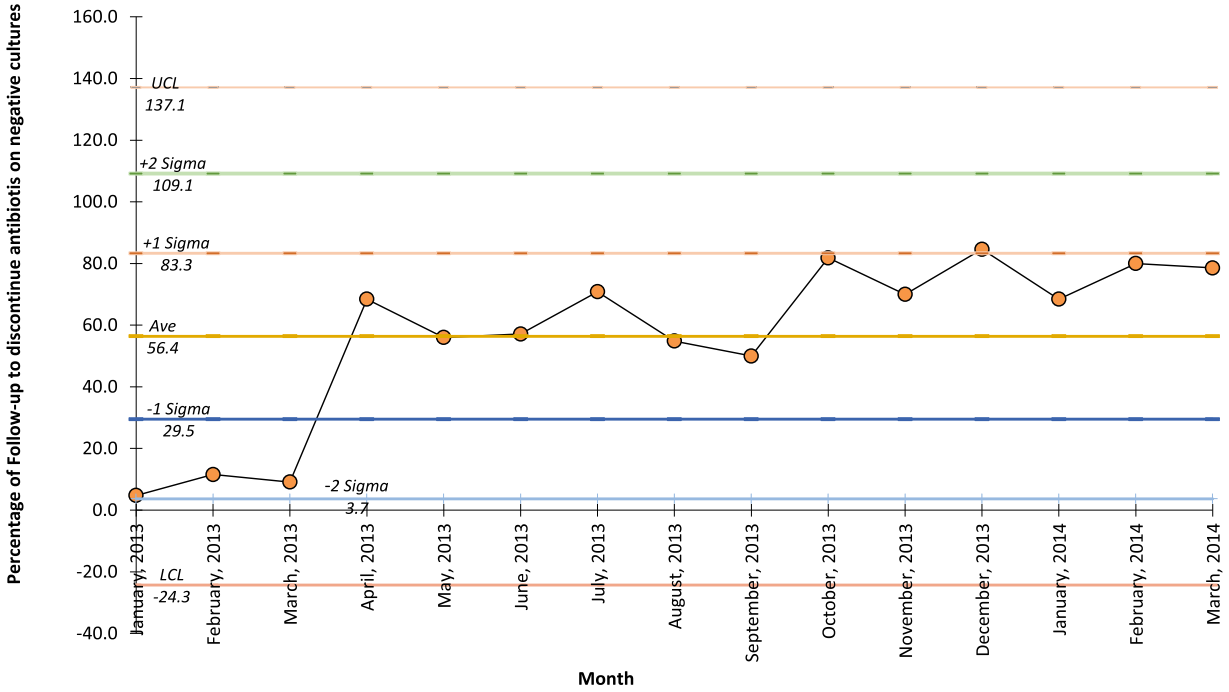
FIGURE 2. Proportion of follow-up calls to discontinue medications after negative culture results were received, by month.



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(OR) from before to after change implementation ($OR = 30.34$, $z = -7.46$, $p < .001$, 95% confidence interval = 10.78, 85.38).

DISCUSSION

The purpose of this QIP was to improve the processes for patient callback for urine cultures after a pediatric ED or urgent care visit. The results of this QIP suggest that relatively inexpensive and simple changes in processes can have an impact on care delivery. This updated follow-up system in the ED provided APPs an opportunity to provide better care to patients and families. In addition, unnecessary antibiotic use was greatly reduced.

The creation of the 2-hour CCB shift (PDSA #1) altered the way laboratory follow-up occurs in the ED. In Aim 1 we were seeking a 33% reduction in time to follow-up but ended up with a 64.7% time reduction. The goal originated from the estimate of reporting equally throughout the day. However, it was found that the laboratory reports urine cultures more often in the morning than at other times of the day. APPs used to try to "keep up" with results as they were reported by the laboratory throughout the day. Results from PDSA #1 included an average 31.8% improvement in time to follow-up. Because of the remarkable decrease in time to follow-up in our first aim, this process will remain a permanent change within the ED.

The percentage of patients who received follow-up notification of negative urine cultures and were told to discontinue antibiotic therapy increased from 8.8% to 74.4%. This outcome reduces unnecessary antibiotic use that could lead to adverse effects and antibiotic resistance. The results of this Aim slightly exceeded preintervention goals as well. The two interventions that seemed to have the largest effect on this goal were the 2-hour CCB shift (PDSA #1) and the clinical care guidelines and process protocol (PDSA #3). Creating the CCB shift accounted for an initial increase of 51.7%; the clinical guidelines accounted for the remainder (13.9%).

Interpretation

The likelihood that these changes will weaken over time is low because these QI changes are being monitored daily by APPs. If an APP does not perform the tasks, the APP on the next shift will see the missed follow-ups and investigate missed processes. In addition, the project coordinator will continue to educate new employees about these processes on an ongoing basis.

Unexpected benefits arose during the improvement process as well that were useful in both the short- and long-term to improve quality and the care experience for the patients, the department, and the hospital system.

Patients

- Referrals to specialists increased and were performed more quickly and efficiently because of frequent case discussions by the CCB provider.

- Patient/family satisfaction scores increased because of more frequent contact and quicker service/follow-up. A 33% increase in total family contact occurred from period Q1 to Q5.

Hospital system

- Responsibilities of the laboratory staff decreased because providers in the ED and NOC sites took ownership of this clinical care via the "in-basket," providing more immediate results.
- The potential of medico-legal risk due to delayed care decreased.

Department/unit

- APP medical knowledge pertaining to the microbiology of urine cultures increased.
- The workload of attending physicians and staff registered nurses (RNs) decreased because the responsibility of culture follow-up is now shared by APPs.
- APPs have increased responsibility to efficiently follow up on problems that could arise.

The current system could be further improved by using RNs as the follow-up provider. RNs could call the families because both protocol and antibiotic guidelines have been developed. When problems arise, the RN could ask an available APP for consultation. This change could further reduce costs of the CCB system.

In addition, it is possible that too many urine cultures are being performed. To be more fiscally responsible, guidelines and department education is needed to reduce unnecessary laboratory use to save time and money. Investigation of this phenomenon could be another QIP entirely. Finally, antibiotic stewardship is another area of further investigation and is likely because of strong hospital-wide support for this important clinical change.

Cost-Benefit

No outside funding was solicited or received for this QIP. The new 2-hour shift for the APPs cost 14 total hours per week (2 hours daily × 7 days), which is roughly $38,000 per year in our system. To offset the new costs, 15 hours per week (Monday through Friday, 3 hours each day) were cut from the APP schedule, representing a reduction of $41,000. This step resulted in a small cost reduction in staffing. There was no added cost for EMR changes.

Limitations

A number of limitations are acknowledged with this QIP. First, the project took place in a single pediatric health system, and therefore the QIP findings should not be considered generalizable to other systems. Next, we did not determine if providers were following guidelines correctly, and we did not study long-term patient outcomes. This is an area for future inquiry, possibly with qualitative research methods. Finally, because of the nature of PDSA trials, we cannot accurately determine the most effective interventions. Each PDSA intervention was added to already completed previous PDSA interventions, and there is no way to control for the cumulative effect of change.

CONCLUSIONS

The positive results of this QIP benefited pediatric patients, parents, and providers at the CHCO. There has been a significant decrease in time to follow-up of urine cultures that affects the potential for renal scarring and parenchymal damage (Finnell et al., 2011). Timely follow-up also lowers the risk for sepsis in patients with UTIs who are not treated in a timely fashion (Oh et al., 2012). Parents and children benefit from health care that is conscientious, complete, and meets their needs. Health systems and health care providers benefit when care processes are changed through a carefully measured and monitored QI effort. The improvements will serve to improve patient care, decrease costs, increase customer satisfaction, and reduce medico-legal risk. Other health care facilities may benefit from these QIP findings by implementing similar interventions and evaluating the effects of scheduled and appointed laboratory follow-up. This process can be expanded to other areas of health care such as inpatient units, outpatient clinics, and laboratory services.

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