Individual QI projects from single institutions

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Improving Adherence to Evidence-based Practice for Uncomplicated UTI in a Pediatric Emergency Department

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Abstract

Introduction: Uncomplicated urinary tract infections (uUTIs) are among the more common pediatric bacterial infections. Despite their prevalence, significant variability exists in the treatment duration and antibiotic selection for uUTI. Our first aim was to improve adherence to a three-day course of antibiotic treatment for uUTI in children over 24 months old. Our second aim was to increase the selection of cephalexin in this population. **Methods:** We conducted a single-center quality improvement study from March 2021 to March 2022. One thousand four hundred thirty-five patients were included across our baseline and intervention periods. We created an order set with embedded discharge prescriptions and followed this with education and provider feedback. The outcome measures for this study were percent of children receiving 3 days of antibiotic treatment and percent of children prescribed cephalexin. In addition, we tracked order set use as a process measure, and 7-day emergency department revisit as a balancing measure. **Results:** Rates of 3-day prescriptions for uUTI demonstrated special cause variation with an increase from 3% to 44%. Prescription rates of cephalexin for uUTI demonstrated special cause variation with an increase from 49% to 74%. The process measure of order set use improved from 0% to 49% after implementation. No change occurred in 7-day emergency department revisits. **Conclusion:** We demonstrated improved use of shorter course therapy for uUTI with a first-generation cephalosporin throughout this project without adverse events. We leveraged an order set with embedded discharge prescriptions to achieve our goals. *(Pediatr Qual Saf 2023;8:e654; doi: 10.1097/pq9.0000000000000654; Published online May 22, 2023.)*

INTRODUCTION

Uncomplicated urinary tract infections (uUTIs) are among the more common bacterial infections in children. Despite their prevalence, significant variability exists in the treatment duration and antibiotic selection for uUTI.[1] Emerging evidence in the pediatric literature suggests a shorter duration of antibiotics for uUTIs is both efficacious and safe.[2–6] Clinical guidelines from the United Kingdom, Australia and New Zealand recommend 3 days of antibiotic therapy for children 3 months and older with uUTI.[3,4] A large, multicenter, randomized, double-blind, placebo-controlled trial of children aged 2 to ten years evaluating 5 days compared with ten days of treatment showed treatment success in 96% of children who received 5 days of treatment and no significant differences in recurrent infection or adverse events between groups.[5] Three days of treatment duration is strongly supported in the literature on adult female patients with multiple prospective randomized controlled trials showing equal efficacy with longer treatment duration.[7–9] The Infectious Diseases Society of America recommends 3 days of antibiotic therapy for uUTI in adult women.[10] Shorter treatment for uUTIs may reduce healthcare costs, antimicrobial resistance, the risk of drug-related toxicity and/or adverse effects, and increase patient adherence to prescribed regimens.[11] Treatment of pediatric uUTIs with first-generation cephalosporins is efficacious with low rates of antimicrobial resistance.[12,13]

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Supplemental digital content is available for this article. Clickable URL citations appear in the text.

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To cite: Kline JN, Powell LN, Albert JD, Bishara AC, Heffren JC, Badolato GM, Berkowitz DD. Improving Adherence to Evidence Based Practice for Uncomplicated UTI in a Pediatric Emergency Department. Pediatr Qual Saf 2023;8:e654.

Received for publication August 15, 2022; Accepted April 20, 2023.

Published online May 22, 2023

DOI: 10.1097/pq9.0000000000000654

Our institution's clinical management of uUTIs lagged behind evidence-based best clinical practice. Most uUTI patients received a third-generation cephalosporin for up to ten days, which aligns with other tertiary care practices.[14]

We set 2 goals. First, to increase the proportion of children aged 24 months and older discharged with uUTI from the emergency department (ED) with an antimicrobial prescription limited to 3 days from 3% to 50%. Second, in the same population, to increase the proportion of patients discharged with cephalexin as the first-line drug of choice from 49% to 65%.

METHODS

Context

We conducted this quality improvement (QI) project in a Level 1 academic children's hospital ED with approximately 90,000 annual visits. ED medical providers include board-certified pediatric emergency medicine physicians (PEM), general pediatricians, pediatric residents, and physician assistants. In addition, ED pharmacists review all patient medication orders and discharge prescriptions. Cerner (Cerner Corporation, Kansas City, Mo.) is the primary electronic health record (EHR) in the ED and across the hospital system.

The target population was ED patients aged 24 months or older discharged from the ED between March 2021 and March 2022 with an International Classification of Diseases 10th Revision (ICD-10) diagnosis of urinary tract infection and a prescription for antibiotics. We excluded patients who presented in triage with fever (≥38°C) or those with an ICD-10 code for pyelonephritis.

Planning of Key Interventions

We formed a multidisciplinary panel in March 2021 composed of a data analyst and physicians with expertise in pediatric emergency medicine, infectious diseases, QI methodology, informatics, pharmacy and medical education. In addition, the hospital-level antimicrobial stewardship committee provided *ad hoc* support.

After reviewing baseline data, the panel identified goals, strategies, performance metrics, and planned the interventions. We recognize some uncertainty in what constitutes best practice for short-duration therapy for pediatric uUTI, particularly 5 or 3 days.[2–6] After reviewing relevant literature with input from infectious disease physicians and pharmacists, we recommended 3 days of treatment with cephalexin for uUTI.[2–6] Local antimicrobial resistance patterns combined with an effort to narrow treatment from the observed practice of prescribing third-generation cephalosporins supported the choice of cephalexin.

We developed 2 key driver diagrams to reflect the 2 aims (Figures 1a and 1b). The key driver diagrams translated the high-level improvement goals into a pictorial roadmap and communicated the goals to our stakeholders.

Interventions

ED UTI Order Set

We created an ED order set containing recommended antibiotics and their respective durations with assistance from leaders in our emergency medicine, infectious diseases, and pharmacy departments (including the hospital-wide antimicrobial stewardship program) and by reviewing local antibiotic susceptibilities. The primary target of this order set was to shorten the recommended antibiotic duration to 3 days and to recommend cephalexin as the first-line treatment for uUTI. The order set was implemented on April 9, 2021 (**See table, Supplemental Digital Content 1**, which shows Antibiotic choice and duration recommendations embedded in to order set. http://links.lww.com/PQ9/A482). The order set distinguished between uUTI and pyelonephritis and differentiated between age groups. In addition, the order set included the preferred antibiotic, its dose, and its frequency.

Provider feedback led us to create a discharge prescription within the order set. These prescriptions were available only for suggested antibiotics, with cephalexin as the first choice for uUTI, and the duration defaulted to 3 days. This addition was a change from the previous state, which required the provider to choose the prescription at the time of discharge and had no guidance about duration or choice of antibiotic. Furthermore, the order set included first dose delivery in the ED, further increasing compliance with recommended prescribing practices.

ED Provider Education

The infectious diseases fellows presented education at staff meetings in May 2021 and returned in October 2021. The ED physician group initially protested adopting a 3-day antibiotic treatment course and using first-generation cephalosporins. We learned that bringing colleagues from the division of infectious diseases to explain the rationale for the order set, the duration's safety and efficacy, and the antibiotic choice paved the way for ED provider acceptance. ED providers and fellows engaged in question-and-answer sessions to promote acceptance and collect strategies to increase compliance with the best available evidence.

Feedback to ED Physician Group

Staff received emails in August 2021, October 2021 and December 2021 containing a P chart demonstrating improvement in the percentage of patients receiving three days of antibiotics and a P chart demonstrating improvement in cephalexin prescription. Also, front-line ED pharmacists educated ED providers in real-time at the time of treatment and prescription.

Measures

The first outcome measure was the percentage of patients prescribed a 3-day course of treatment for uUTI. The second outcome measure was the percentage of patients prescribed cephalexin for uUTI. The process measure was order set use, abstracted as a binary variable from the

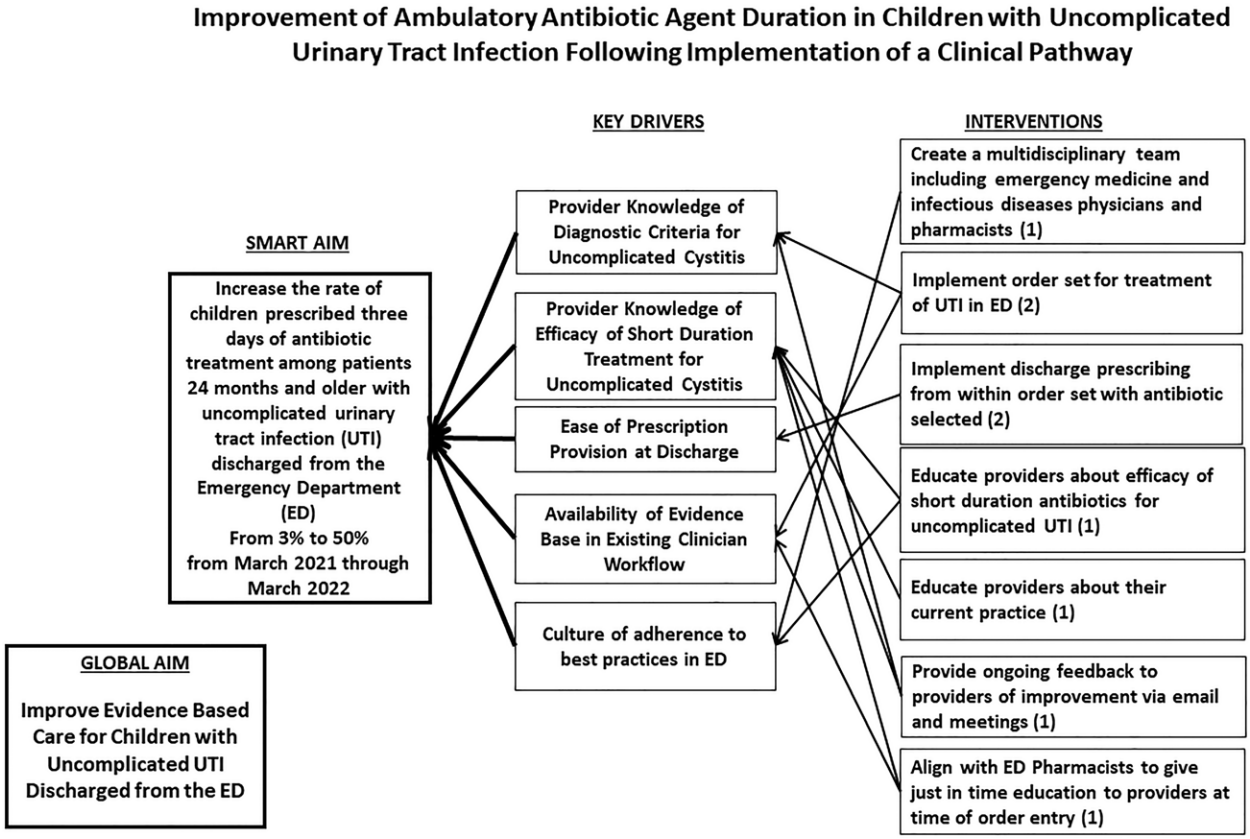

Fig. 1. Key Driver Diagrams. A, Key Driver Diagram: improvement of ambulatory antibiotic agent duration in children with uncomplicated urinary tract infection following implementation of a clinical pathway. Level of reliability of 1 (education and feedback efforts) and 2 (developing error-proof systems embedded in the EHR) no level 3 interventions were used. B, Key Driver Diagram: improvement of ambulatory antibiotic agent selection in children with uncomplicated urinary tract infection following implementation of a clinical pathway. Level of reliability of 1 (education and feedback efforts) and 2 (developing error-proof systems embedded in the EHR) no level 3 interventions were used.

EHR. Finally, the balancing measure was the percentage of patients with 7-day ED revisits.

Analysis

We analyzed all data using statistical process control (SPC) charts created using QI Macros for Excel Version 2019.03 (Know Ware International Inc. Denver, Colo.). We evaluated data 24 months before the initial intervention to calculate the baseline center line and control limits. We chose a longer duration of baseline data as the SARS CoV2 pandemic struck in March 2020, and we wanted to be sure we demonstrated a baseline that included points before and after the pandemic. Significant shifts in the measures (ie, special cause variation) were prospectively identified using traditional rules for patterns on statistical process control, including 8 consecutive measurements persistently above or below the mean, 2 out of 3 consecutive data points at the outer third of upper or lower limits, or 6 consecutive points trending up or down.[15] We calculated new control limits and centerline only if a sustaining system shift was observed prospectively using traditional rules. Given our large sample size, we could report our data in 2-week increments while maintaining the statistical ability to demonstrate special cause; this allowed for more rapid detection of signals using statistical process control charts.

Ethical Considerations

The Institutional Review Board of Children's National Hospital approved the study.

RESULTS

Between April 2019 and March 2022, 1435 patients aged 2 years or older were treated for uUTI and discharged from the pediatric ED, the median age was 9 years (interquartile range 5.1 to 16.7 years), and 88% were female. Rates of 3-day prescriptions for uUTI increased from 3 % to 44%, a 41% increase (Fig. 2A). These data also show a decrease in antibiotic duration prescribed from a baseline of 8.3 days to 5.4 days (Fig. 2B). Prescription of cephalexin for uUTI increased by 26% from a baseline of 49% to 74% after the ED achieved full-time pharmacist staffing (Fig. 3). Results for duration and choice of antibiotic were sustained for 12 months. The process measure of order set use demonstrated

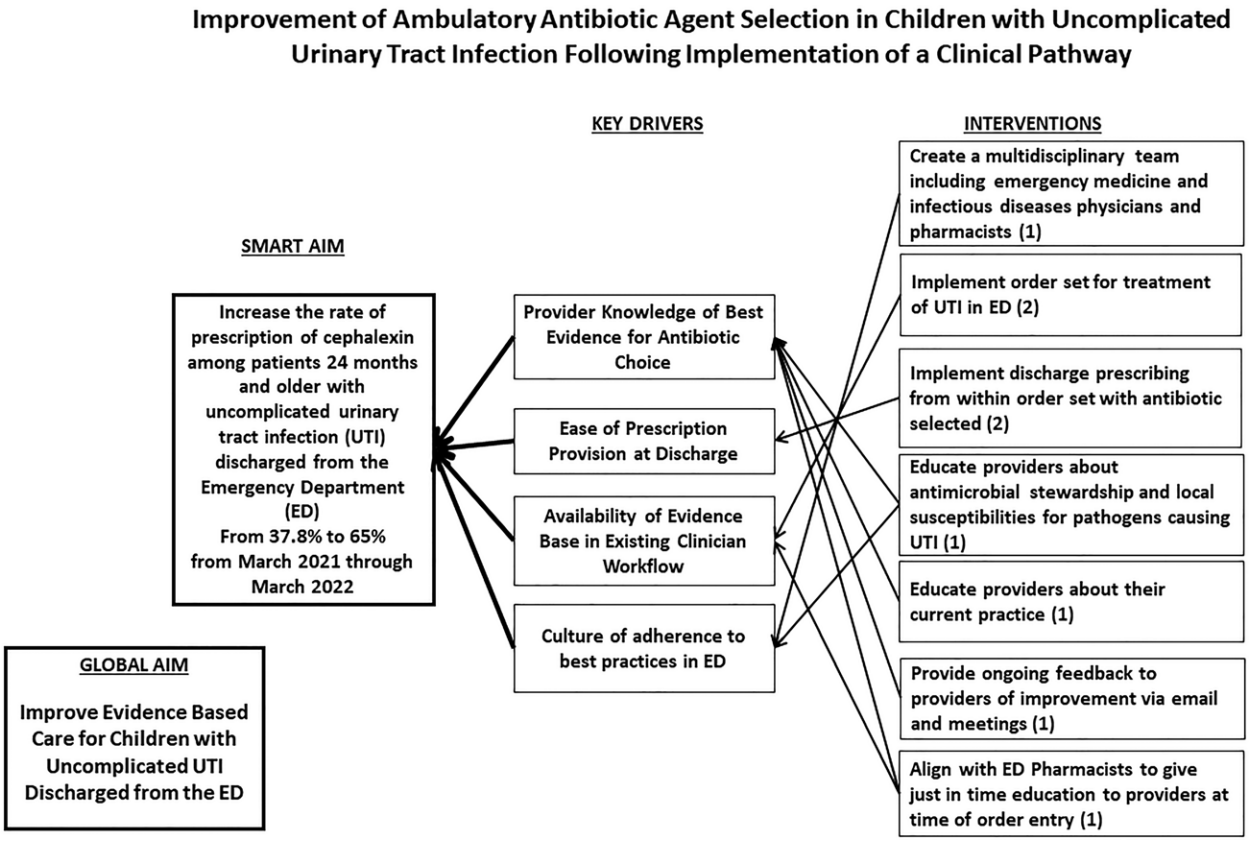

Fig. 1. Continued.

early adoption with special cause variation improving use from 27% to 49% within 4 months of its creation (Fig. 4). No change occurred in 7-day ED revisits (Fig. 5).

DISCUSSION

Summary

We successfully decreased the average number of days antibiotics were prescribed from 8.3 to 5.4, with 44% of patients prescribed the recommended 3 days of treatment by implementing an order set with embedded discharge instructions. Initial improvements were sustained through follow-up with education and feedback to staff. Improved adherence to first-generation cephalosporin occurred throughout this project. Revisit rates remained unchanged. This study adds to a small body of literature on adherence to improved antibiotic stewardship for treating uUTI in children.[16–18] Our study is the first to focus on implementing a 3-day treatment course for uUTI in a pediatric ED.

Interpretation

The order set was the primary driver of change among providers. Order set use is a part of standard practice in the ED at our institution and has been utilized to implement prior QI efforts.[19] We successfully leveraged the existing culture at our institution to implement this practice change recommendation. Standardization of care via order set use has been shown to drive practice for other disease processes at other institutions.[20–22]

Embedding an option for automated order entry with prefilled fields for drug choice and duration within the order set improved adherence to the recommended management of uUTI. This order set was among the first to utilize this technology in our ED. Although we are unable to track defaulted prescriptions as an intervention independent of the order set use itself, we believe this functionality led to further adherence with best practice as it takes fewer "clicks" and less time in the EHR for the ordering provider to create a prescription and electronically send it.[23] Embedding prescriptions in order sets improves compliance with desired practice.[24] We tracked order set use as a process measure and improved its use to 49% of visits for uUTI. In addition, we achieved a correlated improvement in the outcome measure of 3-day antibiotic prescription, achieving this goal for 44% of visits for uUTI. This demonstrates a high correlation of order set use to 3-day prescription adherence. Our attribution is that making the desired choice faster and easier for the ordering provider increases compliance with our goals.

At the outset of this project, we set a goal to treat 50% of children with uUTI with a 3-day course of cephalexin. We fell slightly short of this goal, reaching

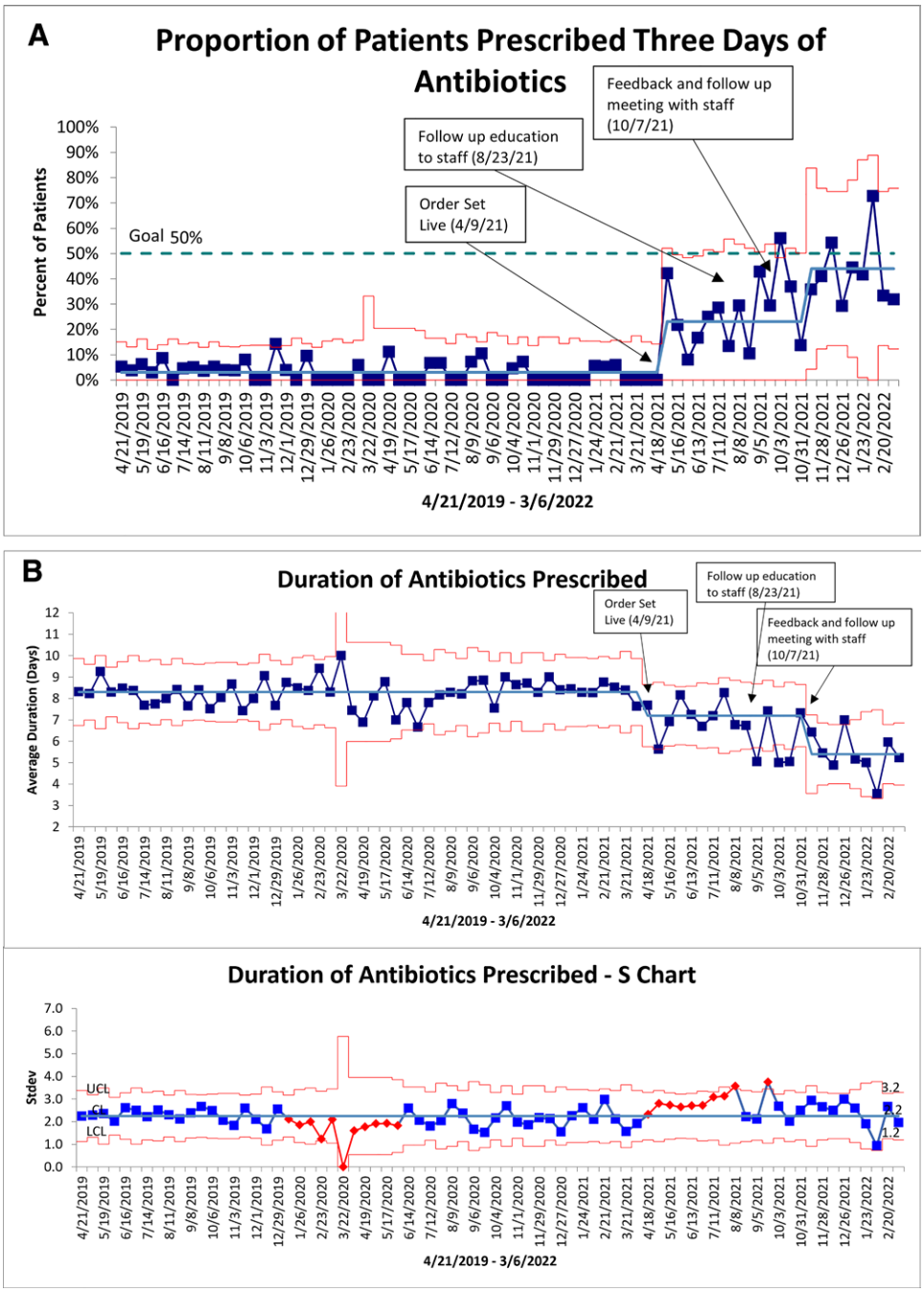

Fig. 2. Statistical Process Control Charts Displaying Antibiotic Duration. A, *P* chart of the proportion of patients prescribed 3 days of antibiotics for uncomplicated urinary tract infection. B, X bar S chart of Duration of Antibiotics Prescribed.

44% and demonstrating an average of 5.4 days duration across all visits. These findings may be due to providers ordering testing and treatment a la carte despite their presence in the order set.[25] We also analyzed prescriptions for all antibiotics, not only cephalexin. However, it was outside this project's scope to assess provider behavior for what resources they utilized when deciding the antibiotic type and duration for individual patients.

Importantly, we showed no change in 7-day return rates during our interventions. Several points were above upper control limits and occurred at the onset of the SARS-CoV-2 pandemic and during the low ED volume that followed before the project's initiation. These findings were likely artifacts of low ED volumes and patient hesitancy to seek care during the pandemic.[26]

LIMITATIONS

There are several limitations to our project. First, we recognize that our ability to leverage the EHR changes we implemented may not be generalizable, which would

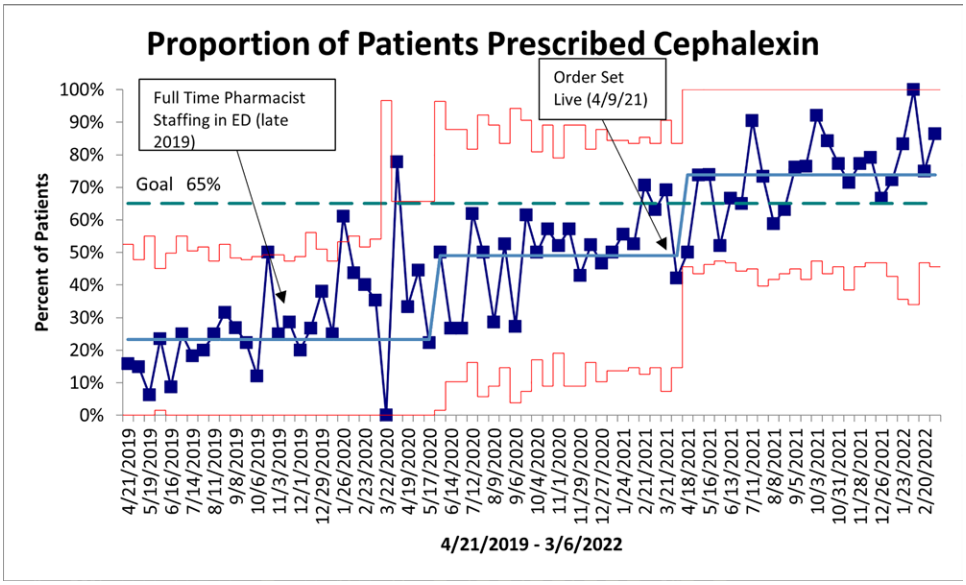

Fig. 3. *P* chart of the Proportion of Patients Prescribed Cephalexin for Uncomplicated Urinary Tract Infection.

hinder duplication of our results. Second, our on-site ED pharmacists contributed to provider education and compliance.[27,28] We recognize that the prescription of cephalexin increased both before and during our intervention period; the increasing presence of on-site dedicated pharmacists and improved provider awareness of antimicrobial stewardship outside this project may have impacted that result. Third, our data abstraction may have been subject to over or under-sampling as we relied on ICD-10 codes to determine inclusion. Fourth, as this was a QI effort to influence provider behavior during the ED visit, we did not consider culture-proven cystitis as a metric but rather a diagnosis at ED discharge. Finally, we measured 7-day return rates as a balancing measure and recognized that this would not capture patients who received subsequent care outside our institution. We also did not gather data on the culture-proven disease. We, therefore, did not report on patients for whom an antibiotic was changed after ED discharge due to the urine culture showing susceptibilities that prohibited a short course of cephalexin. Local susceptibilities predicted that this would be rare in our population.

CONCLUSIONS

Throughout this project, we demonstrated improved use of shorter course therapy for uUTI with a first-generation cephalosporin. In addition, we leveraged an order set with embedded discharge prescriptions to achieve our goals.

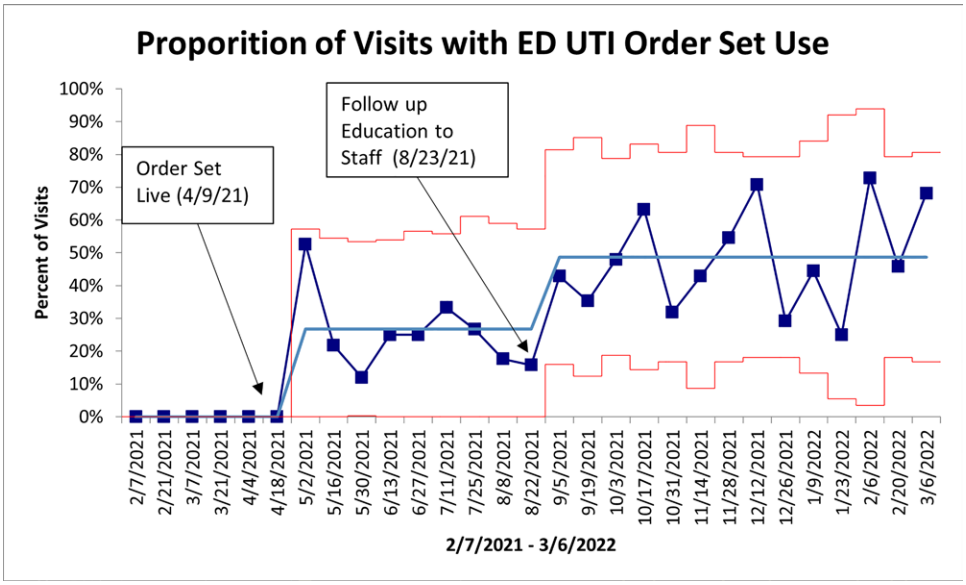

Fig. 4. *P* chart of percent of ED visits for uncomplicated urinary tract infection with ED UTI order set use.

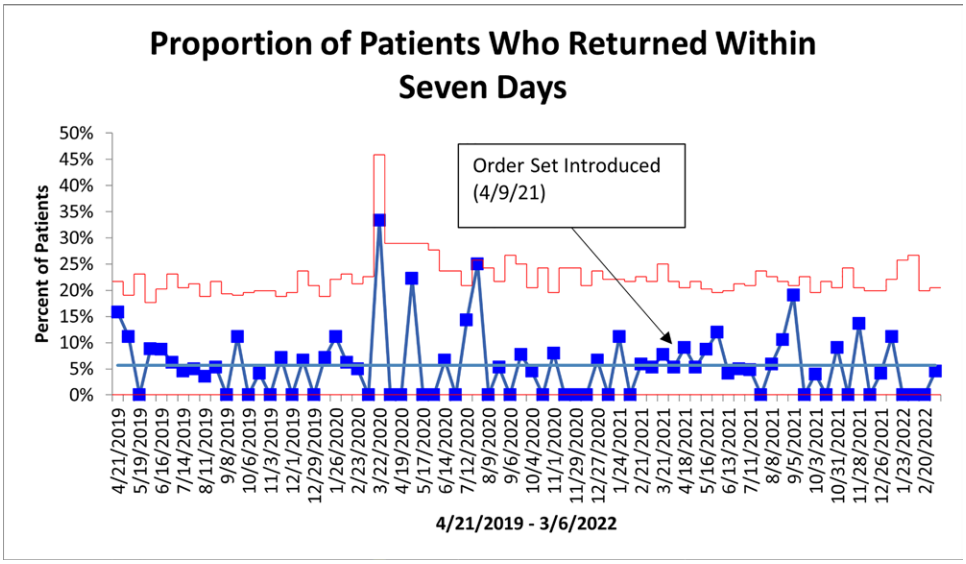

Fig. 5. *P* chart of percent of patients with uncomplicated urinary tract infection who returned to the ED within 7 days.

Our results suggest that these are viable strategies to improve antibiotic stewardship without harm to patients. Future efforts should focus on rolling out embedded discharge prescriptions to other diagnoses and spreading this effort to regional EDs.

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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