Decreasing Duration of Antibiotic Prescribing for Uncomplicated Skin and Soft Tissue Infections

Christine L. Schuler, MD, MPH,a Joshua D. Courter, PharmD,b Shannon E. Conneely, MD,c Meredith A. Frost, MD,c Michael G. Sherenian, MD, c Samir S. Shah, MD, MSCE, ad Craig H. Gosdin, MD, MSHAa

Dr Schuler analyzed and interpreted data, drafted the initial manuscript, and reviewed and revised the manuscript; Dr Courter conceptualized and carried out the project and reviewed and revised the manuscript; Drs Frost, Sherenian, and Conneely assisted in data collection and reviewed the manuscript; Dr Shah conceptualized and carried out the project, interpreted data, and reviewed and revised the manuscript; Dr Gosdin conceptualized and carried out the project, analyzed and interpreted data, and reviewed and revised the manuscript; and all authors approved the final manuscript as submitted.

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Address correspondence to Christine L. Schuler, MD, MPH, Cincinnati Children’s Hospital Medical Center, 3333 Burnet Ave, MLC 3024, Cincinnati, OH 45299. E-mail: christine.schuler@cchmc.org

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abstract

BACKGROUND AND OBJECTIVE: Short courses of antibiotics are often indicated for uncomplicated skin and soft tissue infections (uSSTIs). Our objective was to decrease duration of antibiotics prescribed in children hospitalized for uSSTIs by using quality improvement (QI) methods.

METHODS: QI methods were used to decrease duration of antibiotics prescribed upon hospital discharge for uSSTIs. We sought to accomplish this goal by increasing outpatient prescriptions for short courses of therapy (≤7 days). Key drivers included awareness of evidence among physicians, changing the culture of prescribing, buy-in from prescribers, and monitoring of prescribing. Physician education, modification of antibiotic order sets for discharge prescriptions, and continual identification and mitigation of therapy plans, were key interventions implemented by using plan-do-study-act cycles. A run chart assessed the impact of the interventions over time.

RESULTS: We identified 641 index admissions for uSSTIs over a 23-month period for patients aged >90 days to 18 years. The proportion of children discharged with short courses of antibiotics increased from a baseline median of 23% to 74%, which was sustained for 6 months. Differences in the proportion of children admitted for treatment failure or recurrence before and after project initiation were not significant.

CONCLUSIONS: Using QI methodology, we decreased duration of antibiotics prescribed in children hospitalized for uSSTIs by increasing prescriptions for short courses of antibiotics. Modification of electronic order sets for discharge prescriptions allowed for sustained improvement in prescribing practices. Our findings support the use of shorter outpatient antibiotic courses in most children with uSSTIs, and suggest criteria for complicated SSTIs.

Skin and soft tissue infections (SSTIs) are common in children accounting for the eighth most prevalent cause of hospitalization at children’s hospitals.1 The incidence of SSTIs is increasing, in part due to emergence of methicillin resistant Staphylococcus aureus.3 SSTIs suggest that antibiotic courses of 5 days are effective in cases of nonpurulent cellulitis, with extension of treatment as indicated in cases without notable clinical improvement in that time.4 Short courses of antibiotics may be beneficial to help prevent development of resistant bacteria, lessen cost, and reduce the
chances of unintended effects of antimicrobial therapy.\textsuperscript{5}

Despite the commonality of SSTIs, and published guidelines regarding treatment regimens,\textsuperscript{4,6} variation remains in treatment practices at our institution. Some variation may be attributable to provider preference. However, lack of consensus on what constitutes complicated (cSSTIs) and uncomplicated SSTIs (uSSTIs) may also be contributing to variation in length of therapy for SSTIs. Factors such as severity or location of infection, underlying immunodeficiency, or age of the patient, have been suggested as factors that should be considered in treatment plans.\textsuperscript{6} These factors, as well as others, could potentially influence treatment decisions with regard to both duration of antibiotic therapy and choice of antimicrobial agent.

Given that children at our institution sometimes receive longer courses of antimicrobial therapy for SSTIs than may be necessary, and that duration of inpatient treatment was already brief (median duration of 1.2 days), our objective was to decrease duration of antibiotics prescribed in children hospitalized for uSSTIs by using quality improvement (QI) methods. We sought to accomplish this goal by increasing prescriptions for short courses of antibiotic therapy upon discharge.

\textbf{METHODS}

\textbf{Protection of Human Subjects}

The Cincinnati Children’s Hospital Medical Center (CCHMC) Institutional Review Board determined this project was not human subjects research and thus exempt from human subjects review.

\textbf{Setting}

The study took place at CCHMC, a large academic medical center serving children from rural and urban areas in and around Greater Cincinnati. Children are routinely admitted at 2 locations within the CCHMC system, including the main urban campus and a smaller satellite facility in a nearby suburban area. At CCHMC, SSTIs are the fourth most common reason for admission to the Hospital Medicine Clinical Services, accounting for 452 admissions in fiscal year 2013. Although Division of Hospital Medicine physicians provide care for most patients, ~10\% of patients admitted to the Hospital Medicine Clinical Services receive care from their primary pediatrician. Resident physicians routinely participate in the care of children admitted to services on main campus, and attending physicians provide direct, independent care at the satellite facility.

\textbf{Planning the Intervention}

The improvement team consisted of a team leader from Hospital Medicine, representatives from the Infectious Diseases division, a pharmacist, and pediatric residents. Our goal was to decrease duration of antibiotics prescribed in children hospitalized for uSSTIs by using QI methods. Due to a short median inpatient stay for patients with uSSTI in our institution, ~1.2 days, the median discharge prescription duration was the focus for improving the total antibiotic duration. Our specific aim was to increase the percentage of patients discharged after admission for uSSTI with 7 days or fewer (eg, short course) of prescribed outpatient antibiotic therapy from a baseline of 23\% to 80\% between August of 2012 and February of 2013.

\textbf{Modification of Electronic Order Sets}

We identified 4 key drivers for implementing this change in prescribing practices, including: (1) awareness of Infectious Diseases Society of America guidelines and other pertinent evidence among physicians, (2) changing the culture of physician prescribing to include discussion of duration of therapy at admission, (3) buy in from prescribers, and (4) effective monitoring of prescribing (Fig 1).

\textbf{Physician Education}

The physician education component focused on resident and attending physician education. We organized two 15-minute didactic sessions for both attending and resident physicians in September 2012. Education sessions for attending physicians were incorporated into regularly scheduled team meetings. Sessions for residents took place during routinely scheduled educational conferences. Project staff presented at each of these sessions, provided background information, and clarified recommendations about short courses of antibiotics for uSSTIs.

\textbf{Access to Best Practices}

Lanyard cards were distributed after educational sessions in the ensuing 3 to 5 weeks (September through October 2012) to ensure providers had pertinent information in a written form that was conveniently accessible in the patient care setting. Lanyard cards included information on optimal antibiotic duration and suggested treatment regimens according to evidence available at the time of the project.\textsuperscript{6,7} We specifically designed lanyard cards to be attached to personnel badges for ease of use in the clinical setting (Fig 2).
This modification was electronically linked to outpatient prescriptions. When the antibiotic prescription was electronically written upon discharge, duration of therapy defaulted to a 7-day course, and automatically subtracted out the number of days on antibiotics while hospitalized (Fig 3). Therefore, a patient discharged after having had 1 day of antibiotic therapy while hospitalized would receive a discharge prescription for 6 days of therapy. This intervention ensured that providers had to actively modify the duration of prescribed antimicrobial therapy to a longer course if they thought that was warranted.

Identification and Mitigation

The final intervention was identification and mitigation of antibiotic plans before discharge. In November 2012, we began daily medical record review for all patients admitted to hospital or community medicine teams with SSTIs. We identified cases by reviewing the patient census each morning and finding patients admitted for SSTIs. A project team member contacted a member of the medical team, either the intern or senior resident, within 24 hours of admission via text page through the pager system. The project team member used an established template to reiterate that patients may be candidates for short courses of antibiotics for uSSTIs, remind providers to refer to lanyard cards for recommendations on therapy, and to confirm that a project team member may be contacted with any questions at a designated contact number.
to these patients, and young infants with SSTI may warrant specialized therapy due to relative immune deficiency.\textsuperscript{8} Children with more than 1 admission were included only with regard to their first admission. We excluded patients with cSSTIs. We defined cSSTIs as those occurring in children with (1) immunodeficiency (either primary or acquired), (2) fasciitis, (3) concomitant osteomyelitis, (4) injuries caused by animal or human bites or burns, (5) SSTIs attributable to surgical site infections, or (6) SSTIs involving the head or neck (eg, orbital or peri-orbital cellulitis). These criteria for cSSTIs were clarified for hospital personnel in written form in didactic sessions, on lanyard cards, and in other distributed project materials such as posters. Infections that did not meet criteria for cSSTIs were considered uSSTIs.

**Outcome Assessment**

The primary outcome of interest was duration of prescribed antibiotic therapy after hospitalization for uSSTI measured in days. We determined duration of prescribed therapy through medical record review. We categorized therapy as ≤7 days (short course), and >7 days (standard course). In cases where more than 1 antibiotic was prescribed upon discharge, duration of both agents was considered with duration of antibiotics for analyses defined as the longest duration of either agent prescribed. Also, duration of prescribed therapy for both agents had to be 7 days or fewer to be considered a short course.

**Analysis**

The metric of interest was the duration of prescribed outpatient antibiotic therapy in days for patients discharged after hospitalization for uSSTI. We created a run chart using biweekly data to illustrate the proportion of patients discharged with short courses (7 days or fewer) of outpatient antibiotic therapy over the course of the project. Run charts included only index admissions. Fisher’s exact test was used to determine differences in admissions for recurrences and failures before and after project implementation. We used an $\alpha$ of 0.05 for all analyses.

**RESULTS**

Overall, 641 (67\%) of 963 admissions for uSSTIs to the Hospital Medicine Clinical Services between January 2012 and November 2013 met inclusion criteria. Approximately one-third of admissions occurred before intervention (206 of 641) and two-thirds of admissions after the project initiation (435 of 641).
Ninety percent of admissions were to a hospital medicine service (578 of 641), with all remaining admissions to a community pediatrics service. Median age at time of admission was 2.8 years. Child age and gender did not differ significantly between the 2 time periods (ie, before and after the start of this project).

**Duration of Antibiotic Courses**

Complete antibiotic prescribing information, including antibiotic type and prescribed duration, was obtained for 96% (616 of 641) of eligible index admissions for uSSTIs. The baseline median for prescriptions for short courses of antibiotics was 23%. After study interventions began in September 2012, we noted an increase by February of 2013 in the median proportion of patients discharged with prescriptions for short courses of antimicrobial therapy. Specifically, there was an increase from a median of 23% to 74% of patients discharged with short courses of antimicrobial therapy. This increase was sustained for 6 months after our last intervention, case identification and mitigation, ceased in May 2013 (Fig 4). The median duration of prescribed antibiotic therapy post implementation of interventions, March through November 2013, was 7 days with an interquartile range of 4 to 14 days.

**Antibiotic Choices**

Among discharges with complete prescribing information available, clindamycin was the most commonly used antibiotic, prescribed upon discharge in 88% of cases (539 of 616), followed by trimethoprim-sulfamethoxazole prescribed in 8% of discharges (51 of 616), and cephalexin prescribed in 4% of discharges (23 of 616). Two antibiotics were prescribed upon discharge in ~6% (37 of 616) of admissions with complete prescribing information. Clindamycin was the antibiotic most commonly used in combination with another agent, and was prescribed in 84% (31 of 37) of the cases where 2 antibiotics were prescribed.

**Readmissions**

Few children had more than 1 admission (26 of 641, 4%). Overall, 2% (11 of 641) of subjects were readmitted for a recurrence, and 2% (16 of 641) were admitted for treatment failure. One patient was admitted for both a recurrence and failure. There was no significant difference in the number of subjects requiring readmission for recurrences before (5 of 206, 2.4%) and after project implementation (6 of 435, 1.4%; *P* = .34). Readmissions for treatment failures were not significantly different before (8 of 206, 3.8%) and after project initiation (8 of 435, 1.8%; *P* = .17).
DISCUSSION

Although we did not reach our prespecified goal, our findings indicate that QI methods can decrease duration of antibiotics prescribed in children hospitalized for uSSTIs. Specifically, we decreased duration of therapy by increasing prescriptions for short courses of outpatient therapy upon discharge. We improved prescribing patterns through physician education, promoting access to best practices, modification of electronic order sets for outpatient prescriptions, and case-by-case identification and mitigation. Our interventions led to a sustained increase in prescriptions for short courses of antibiotics 6 months after project completion.

We suspect that our sustained improvement in prescriptions for short courses of antibiotics over multiple months was in large part due to modification of our electronic order set used to generate outpatient prescriptions. This intervention arose out of a multidisciplinary team inclusive of pharmacists who identified the order set default for a 14-day course of therapy as a potential point of intervention. Our order set modification to include a default to a 7-day course forced providers to manually enter longer durations of therapy if they were deemed necessary when the discharge prescription was written. We suspect this modification, in particular, made it easy for providers to prescribe short courses, and was instrumental in sustaining the success we documented.

There are likely multiple reasons why our improvement efforts did not result in short courses of antibiotic therapy prescribed in 80% of cases, which was the goal. It is possible that providers may have been hesitant to prescribe short courses of therapy for select patients. It is also possible that our operational definition of cSSTIs was too narrow, and that some patients who fell into the uSSTIs category according to our criteria actually had characteristics that led providers to choose longer treatment regimens, such as associated bacteremia or slow response to therapy. Our success may also have been hampered by the challenges of maintaining timely communication with medical teams about treatment regimens. Specifically, short hospital stays and early morning discharges may have effectively limited opportunities for the QI team to discuss treatment regimens with providers before discharge. Additionally, in cases where the modified SSTI order set was not used, discharge prescriptions would not have defaulted to short courses.

The educational interventions and case-by-case basis identification and mitigation, we believe, were also important in improving prescription practices. However, these interventions had their own limitations. The impact of educational interventions was likely limited given we could not guarantee all medical providers could attend 1 of the educational sessions. Identification and mitigation strategies were likely beneficial when this could be accomplished in a timely manner, but this was not a realistically sustainable intervention, and certainly some cases were not successfully addressed before discharge.

We chose readmissions for either treatment failure or recurrence as a balancing measure. We felt this was an appropriate factor to consider given our goal to decrease antibiotic overuse while simultaneously ensuring that our interventions did not lead to unintended consequences. We did not observe a significant increase in treatment failures or recurrences after project initiation, and were somewhat reassured that we were appropriately identifying children with uSSTIs for whom short courses of therapy would be suitable. Further studies may help solidify criteria for cSSTIs. However, our definition of cSSTIs may be appropriate to consider when making treatment decisions about SSTIs in children.

This project has several limitations. First, it was conducted at a single site. The culture at CCHMC of continuous QI, and existence of systems that support these efforts, may have influenced our results and could limit the generalizability of our findings. Second, this project focused solely on duration of prescribed outpatient antibiotic therapy at time of discharge. We did not specifically address the role of inpatient therapy given that the median inpatient stay was <2 days. However, duration of inpatient therapy clearly contributes to overall duration of therapy and this should be addressed in future QI efforts. Third, we did not inquire after discharge about additional prescribed outpatient therapy beyond the course prescribed upon discharge. Therefore, it is possible that patients received longer courses of therapy prescribed by outpatient providers. Fourth, our analyses did not account for some clinically relevant variables that may have influenced duration of prescribed therapy, such as incision and drainage, bacteremia, or response to therapy. Finally, we did not track how often providers used our modified SSTI admission order set, which included the default to short courses of therapy. Tracking this information may have been informative in determining reasons we did not meet the prespecified goal.

CONCLUSIONS

QI efforts improved prescribing practices with regard to abbreviated courses of antibiotic therapy in this single site project at a tertiary care center. Future interventions
aimed at improving care for children admitted with uSSTIs should consider duration of therapy in all phases of care, inpatient and outpatient, as well as need for further therapy prescribed by outpatient providers. Standardizing a definition for cSSTIs may also be beneficial in optimizing antimicrobial regimens for hospitalized children.

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ABBREVIATIONS
CCHMC: Cincinnati Children’s Hospital Medical Center
cSSTI: complicated skin and soft tissue infection
QI: quality improvement
SSTI: skin and soft tissue infection
uSSTI: uncomplicated skin and soft tissue infection

REFERENCES


5. Society for Healthcare Epidemiology of America; Infectious Diseases Society of America; Pediatric Infectious Diseases Society. Policy statement on antimicrobial stewardship by the Society for Healthcare Epidemiology of America (SHEA), the Infectious Diseases Society of America (IDSA), and the Pediatric Infectious Diseases Society (PIDS). Infect Control Hosp Epidemiol. 2012;33(4):322–327


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