Individual QI projects from single institutions

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Decreasing Time to Antibiotics for Patients with Sepsis in the Emergency Department

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ABSTRACT

Background: Sepsis is a significant cause of morbidity and mortality. Patients may present in a spectrum, from nonsevere sepsis through septic shock. Literature supports improvement in patient outcomes with timely care. This project describes an effort to improve delays in antibiotic administration in patients with sepsis spectrum disease presenting to a pediatric emergency department (PED). **Objective:** This project aimed to decrease time to antibiotics for patients with sepsis in the PED from 154 to <120 minutes within 2 years. **Methods:** Following the collection of baseline data, we assembled a multidisciplinary team. Specific interventions included staff education, the institution of a best practice alert with order set and standardized huddle response, and local stocking of antibiotics. We included all patients with orders for intravenous antibiotics and blood culture. **Results:** From April 2015 to April 2017, the PED demonstrated reduction in time to antibiotics from 154 to 114 minutes. The time from emergency department (ED) arrival to antibiotic order also improved, from 87 to 59 minutes. **Conclusions:** This initiative improved prioritization and efficiency of care of sepsis, and overall time to antibiotics in this population. The results of this project demonstrate the effectiveness of a multidisciplinary team working to improve an essential time-driven process. *(Pediatr Qual Saf 2019;3:e173; doi: 10.1097/pq9.0000000000000173; Published online May 16, 2019.)*

INTRODUCTION

Among children in the United States, sepsis remains a leading cause of death.[1] Overall, the percent of pediatric hospitalizations attributable to sepsis is increasing.[2] Even among sepsis survivors, the risk of morbidity can be significant with studies estimating 17% will suffer at least moderate disability.[3] Current evidence-based guidelines dictate a focus of efficiency of care, with time to antibiotics and fluid resuscitation of utmost importance.[4–6] Delays in antibiotic administration, specifically, have been associated with prolonged organ dysfunction and mortality.[7]

Studies have demonstrated the ability of quality improvement work to improve adherence to evidence-based care for sepsis resuscitation while linking this to improved outcomes.[8–10] Adult studies have demonstrated the benefit of the "golden hour" of sepsis care; however, much of this work has also focused on severe sepsis and septic shock.[11] At our institution, we identified care inefficiencies in the administration of antibiotics to patients with all degrees of sepsis, including those with nonsevere sepsis.

This initiative aimed to decrease time to antibiotics for patients with sepsis in the pediatric emergency department (PED) from 154 to <120 minutes within 2 years.

METHODS

Improvement Population

At the onset of the project, we identified an operational definition for patients on the sepsis spectrum. To include patients with early or nonsevere sepsis, we defined the inclusion group as patients with orders placed during the PED visit for intravenous antibiotics and a blood culture, at any time during the visit.

Setting

This project was initiated in a PED within a tertiary care children's hospital with a level 1 trauma center and approximately 38,000 annual visits. At the onset of the initiative, no specific screening or treatment algorithms existed for sepsis within the children's hospital. This work

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To cite: Emerson BL, Ciaburri R, Brophy C, Kandil SB. An Initiative to Decrease Time to Antibiotics for Patients with Sepsis in the Pediatric Emergency Department. Pediatr Qual Saf 2019;3:e173.

Received for publication October 29, 2018; Accepted April 2, 2019.

Published online May 16, 2019.

DOI: 10.1097/pq9.0000000000000173

began as an extension of a national initiative to improve sepsis care in PEDs.[12]

Improvement Strategy

A multidisciplinary team organized to drive improvement in this project, including nursing, physician, informatics, and quality representation. We engaged leadership and front-line staff to ensure momentum for change and feasibility of interventions. We utilized a key driver diagram to track the project and the associated intervention work (Fig. 1). Additionally, the team utilized plan-do-study-act methodology to test interventions while scaling the scope of impact. The multidisciplinary improvement team met frequently to undergo plan-do-study-act cycles. We identified processes to implement from subject matter expertise representation and selected by consensus. We audited compliance through random chart review and clinical observation by team members.

Our hospital analytics team built an automated dashboard to ensure availability of real-time performance data. This dashboard provided data, aggregated monthly, regarding all patients in the inclusion group. We measured the time to antibiotic from time of PED arrival to initiation of intravenous antibiotic. In our institution, patients are greeted and arrived at the triage desk, so initiation of PED visit and PED triage are simultaneous.

In initial stages, we developed and trialed a screening tool in paper format at triage. We adopted the tool from the American Academy of Pediatrics' Pediatric Septic Shock Collaborative.[12] Once found acceptable and efficient for use at triage, we integrated the screening tool adapted exactly from the Collaborative into the hospital's electronic health record. We trialed the tool in a test environment by end users before roll out, and refined using their feedback. By analyzing vital signs, nursing assessment, and past medical history data at triage or at any time through PED visit, the screening logic calculated a sepsis score. When the sepsis score crossed above a designated threshold, an electronic message in the form of a best practice alert (BPA) would notify any provider who subsequently logged into the patient's chart. The BPA presented once to each job role entering the patient's chart (physician, nurse, and emergency department technical associate), and could be accepted or declined based on the clinical assessment. The BPA required a response from the user before it could be bypassed. Nonphysician staff could document the acknowledgement of communicating with the responsible physician. With each reentry of vital sign information, the sepsis score would automatically recalculate and another BPA could present to staff.

Similarly, we developed a plan for team communication in conjunction with the triage screening tool. Utilizing a secure text-based technology among care providers, or using face-to-face communication if preferred, a multidisciplinary conversation occurred at bedside. If the decision following this discussion was that the patient presented with an alternative diagnosis to sepsis spectrum disease, the alert could be declined. If, alternatively, the team decided that the patient should be treated for sepsis, the alert could be accepted. If the physician user accepted the alert, he or she was prompted to enter an order set for ease of entering evidence-supported care orders. At this point, additional team members were summoned by another text group to initiate time-sensitive care.

We addressed staff education in several formats. First, the PED makes use of multidisciplinary in situ simulation for education and safety testing. We added a sepsis scenario to the curriculum of bimonthly simulations. Additionally, we included a brief slide show with an interactive quiz with online staff competency module trainings. All nonphysician staff completed this before the project launched and then again about 6 months after

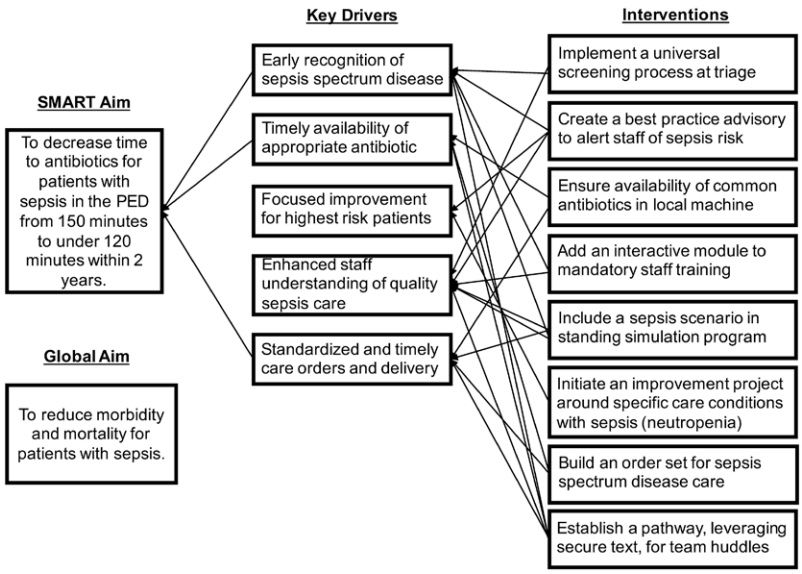

Fig. 1. Key driver diagram.

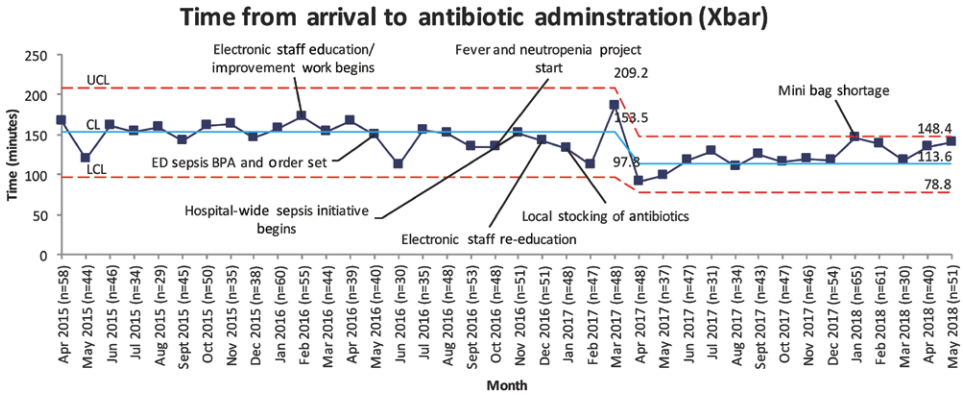

Fig. 2. XBar statistical process control chart: time from arrival to antibiotic order, average per month (in min). CL, center line; ED, emergency department; LCL, lower lontrol Limit; UCL, upper control limit.

the triage screening program began. In conjunction with updates in staff meetings and newsletters, sepsis simulations continue to date.

We identified the local availability of antibiotics as another important driver. Stakeholder staff identified the wait for drug delivery from central pharmacy was inefficient. To this end, we loaded the local medication dispensing machine with premixed commonly used antibiotics, and provided staff education in selecting the appropriate dose.

Data Analysis

We gathered data on an ongoing basis through an automated dashboard, reporting the frequency of patient cases and time to antibiotics. The outcome metric included mean time to antibiotic order (time elapsed between the patient arrival and time of antibiotic order), and process metric included mean time to antibiotic administration (time elapsed between the patient arrival and time of antibiotic administration per medication administration record). Antibiotic administration time is entered by the bedside nurse after the antibiotic is started. We reviewed balancing metrics, but did not note any attributable change, including length of stay, monthly volume of sepsis patients, door to doctor time, and intensive care unit admissions. We gathered a baseline performance assessment before the initiation of improvement work. Additionally, we reviewed data following the completion of the intervention period to ensure sustainability of the work.

To evaluate the impact of interventions on time to antibiotics, we employed statistical process control charts (Figs. 2 and 3). We evaluated these data for special cause, to link interventions to outcomes, using standard rules.[13,14] Following the identification of special cause, we recalculated center lines and control limits to represent the process change.

We did not identify any ethical concerns in the implementation of this work. Per institutional protocol, the institutional review board (IRB) exempted this project from review as quality improvement.

RESULTS

For the purposes of this project, our data included 1,710 patients over 38 months. We noted significant month-to-month patient volume variation, consistent with known seasonal variation of PED patient presentations. Within 1 year of the initiation of this project, times to antibiotic order and antibiotic administration decreased in this PED cohort. The mean time from arrival to antibiotic order decreased from 87 to 59 minutes, and mean time from arrival to

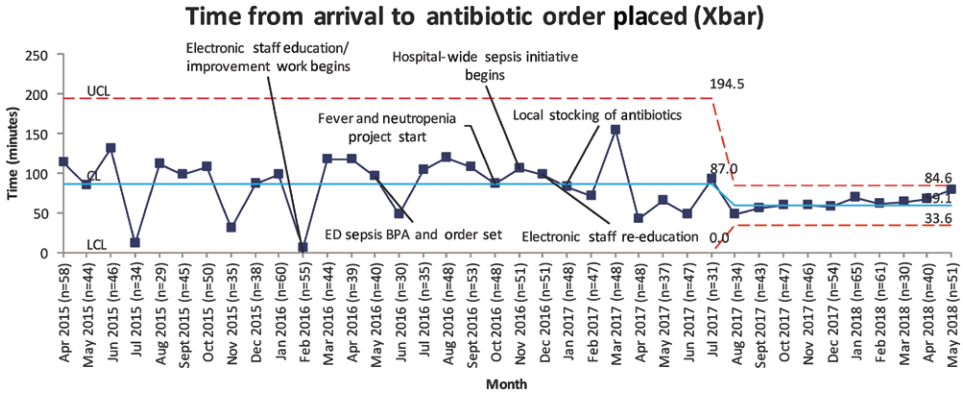

Fig. 3. XBar statistical process control chart: time from arrival to antibiotic administration, average per month (in min). CL, ED, LCL, UCL.

antibiotic administration decreased from 154 to 114 minutes (Figs. 2 and 3) We noted a special cause in August 2017 and April 2017, respectively. Additionally, the variability in time decreased across the project, as noted with narrowing of control limits (93.9–205.4 min, decreased to 78.8–148.4 min) (Fig. 4). These improvements have been sustained to date, over another year of project work.

Institutionally, this specific project coincided with a whole-hospital effort to improve recognition and treatment of sepsis among hospitalized pediatric patients. This began around November of 2016, and is annotated on the control chart for reference. A cross-discipline approach facilitated some interventions and sustainability measures, including promoting local antibiotic stocking across the institution, and driving faster pharmacy delivery of antibiotics to navigate the mini bag shortage. Additionally, we experienced increased transient delays in antibiotic administration in January 2018 related to a drug shortage issue. This impacted local antibiotic availability in the medication dispensing machine on unit. Overall, however, we noted an improvement in time to antibiotics, with decreased variability (Fig. 4). This improvement has been sustained.

DISCUSSION

Overall, the results of this project demonstrated the impact of several process and electronic medical record (EMR)-directed improvements in the efficiency of care of patients within the sepsis spectrum. This project is distinct from currently described work, in that it includes improvement in patients across the spectrum of sepsis, outside of severe sepsis, and septic shock. Additionally, this project adds to the existing work engaging technology and systems-level change to aid in the early identification of patients with potential sepsis physiology.[15]

Despite our challenge in measuring infrequent severe patient outcomes such as mortality, data support a clear connection between process and outcomes in pediatric sepsis care.[7,9] Additionally, the process of reducing patient-to-patient variation in care holds promise in improving outcomes.[16] This project demonstrated average time to antibiotic goals, and narrowing of the control limits indicating a more reliable process. Importantly, we demonstrated benefit in overall time to antibiotic order as a component of time to antibiotic administration, reflecting an improvement in the processes of providing care to patients on the sepsis spectrum.

Stratified analysis in this project provided us with substrate for future improvement work. As we reviewed data in the project, we detected no significant change in the overall time from antibiotic order to antibiotic administration. Also, although we could not segregate the sickest patients by sepsis physiology, we reviewed data specific

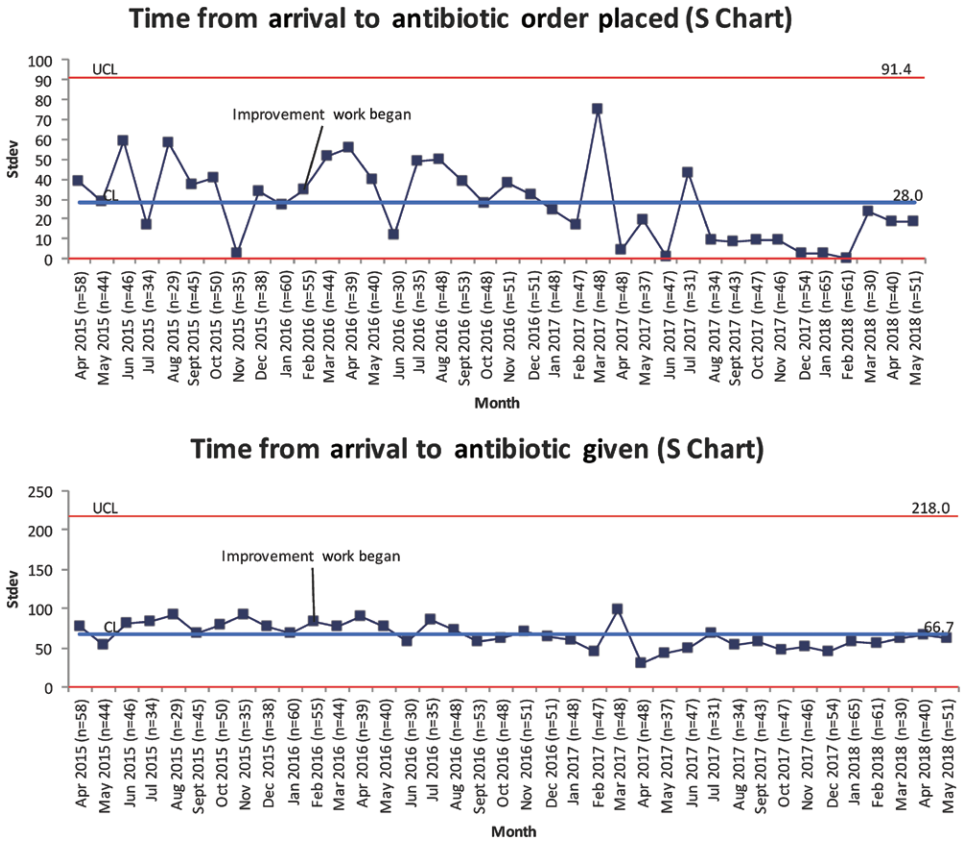

Fig. 4. S statistical process control chart: time from arrival to antibiotic order, and time from arrival to antibiotic administration (SD). CL, center line; UCL, upper control limit.

to the subgroup of these patients admitted to the intensive care unit. The time from arrival to antibiotic administration for this subgroup remained stable. Each of these metrics identifies an opportunity for future improvement.

Similarly, we identified key inefficiencies specific to our fever and neutropenia patients through our process analysis. This is a high-risk group, where time to care is particularly important. To this end, we undertook a separate project to successfully improve time to antibiotics for this specific patient group.[17] This work occurred simultaneously with the other described improvement efforts, and successfully reduced the time to antibiotics for patients with fever and neutropenia from 116 to 55 minutes.

The determination of a time to antibiotic goal is challenging, and the gold standard of 1 hour for severe forms of sepsis may provide other challenges. The lack of a clear evidence-supported benchmark for time to antibiotics in nonsevere sepsis challenged our aim setting. The goal, in this case, should be balanced with the desire to adhere to the best antibiotic stewardship principles. This is in line with the recommendations from the Joint Commission regarding antibiotic stewardship, in creating care algorithms that enhance patient safety and outcomes while considering carefully the need to reduce inappropriate antibiotic usage.[18,19] As such, our team believed that a 20% improvement from baseline was clinically significant without introducing different safety concerns.

Two hours from arrival allowed time for the staff to fully assess the patient and consider alternative diagnoses before administration of antibiotics, but also provided a clear goal for improvement in our overall efficiency in the care of this important population. Our work is sustained to date, but we anticipate continuing to improve care, especially for high-risk patient populations, to best reflect the focus on the "golden hour" of sepsis. For some populations (eg, fever and neutropenia, septic shock) the time to antibiotics should best be 60 minutes, and our future work will focus on these specific subgroups. This more stringent goal will help us to provide targeted improvement work necessary to optimize care for these most acute patients. Additional work will include dissemination throughout our hospital and system. Also, manual post hoc documentation of antibiotic start time may have limited the precision of time metric data collected. Future institutional improvement work will include improving the use of automated time stamp in the electronic health record, to further improve the reliability of time data.

This quality project is limited in its generalizability because it reflects processes of a single clinical setting and for a specific subset of patients. Our process improvements, however, are currently in early stages of spread to other settings within our institution. Future work will analyze the impact of this spread. Also, a simultaneous project aimed to improve the care of our patients with fever and neutropenia which may have impacted our overall sepsis work; however, this represented a small population (approximately 1 per week) with likely smaller effect on our larger sample. Additionally, as a single institution study designed to improve process of antibiotic delivery, the ability to demonstrate improvement in patient outcomes is limited.

CONCLUSIONS

This project demonstrates the effectiveness of addressing interventions beyond the individual clinician to leverage change at the institutional level. This multifaceted approach, involving education, communication, clinical strategies, and system-level strategies is essential in projects aimed toward changing practice.[20] By targeting improvements in the narrow and broad scope, the overall impact is greater.

We developed this article in compliance with SQUIRE 2.0 standards for reporting of quality improvement work.[21] We received no external funding for this work.

ACKNOWLEDGMENTS

Dr. Emerson conceptualized and designed the study, carried out the initial analyses, collected data, participated in intervention implementation, and developed the initial manuscript. Ms. Ciaburri participated in intervention implementation and reviewed and revised the manuscript. Ms. Brophy conceptualized and designed the study (with focus on information technology), participated in intervention implementation, and critically reviewed the manuscript. Dr. Kandil participated in intervention implementation and critically reviewed the manuscript.

DISCLOSURE

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

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