

# Improving Low-acuity Patient Flow in a Pediatric Emergency Department: A System Redesign.

Deena A. Berkowitz, MD, MPH\*†; Kathleen Brown, MD, MPH\*†; Sephora Morrison, MD, MBA\*†; Asha Payne, MD, MPH\*†; Jeannie Pettinichi, MSN\*; Theresa Ryan Schultz, MSN\*; Anthony Thomas, MSN\*; James M. Chamberlain, MD\*†

## Abstract

**Background:** Children's National Health Systems pediatric emergency department (ED), is a level 1 trauma center in Washington, DC, which treats over 90 000 patients annually. Approximately 50% of arriving patients are triaged as low acuity, Emergency Severity Index level 4 or 5. With limited space and resources, these patients are treated inefficiently, with average delays from arrival to provider time of 1.3 hours and length of stays (LOS) close to 2.5 hours. **Objectives:** In July 2016, Children's National Health Systems ED initiated a focused approach to improve both patient flow and experience for these low-acuity patients. **Methods:** We assembled a multidisciplinary ED-based task force. The quality improvement initiative began in January 2017 and consisted of 4 steps: (1) front-end space redesign; (2) implementation of a new front-end patient triage and assessment process; (3) increased doctor and nurse staffing; and (4) dissemination of data updates to reinforce awareness and adherence to workflow. Our process outcomes were arrival-to-provider time and LOS for low-acuity patients. Our balancing measures were the rate of return to the ED within 72 hours and arrival to provider times for high-acuity patients. We used statistical process control methodology to measure the effects of our interventions over time. We performed a secondary analysis to measure the response of wait times to total daily volume comparing preintervention to postintervention. **Results:** We decreased the LOS by 11 minutes (9%) and arrival to MD times 21 minutes (35%) for the same period 1 year apart. (*Pediatr Qual Saf* 2018;3:e122; doi: 10.1097/pq9.000000000000122; Published online December 6, 2018.)

## INTRODUCTION

Pediatric emergency department (ED) overcrowding is a national problem. Like their adult counterparts, many pediatric EDs

From the \*Division of Emergency Medicine, Children's National Medical Center, Wash.; and †Department of Pediatrics, Division of Emergency Medicine, The George Washington University School of Medicine, Washington, DC.

Poster presentation at IHI Scientific Symposium December 11, 2017, Orlando, Fla.

Supported by Division of Emergency Medicine.

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

\*Corresponding author. Address: Deena Berkowitz, MD, MPH, Division of Emergency Medicine, Children's National Medical Center, 111 Michigan Avenue NW, Washington DC 20010. Email: dberkowitz@childrensnational.org  
PH: 202-476-3573; Fax: 202-476-3573

Copyright © 2018 the Author(s). Published by Wolters Kluwer Health, Inc. This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

To cite: Berkowitz DA, Brown K, Morrison S, Payne A, Pettinichi J, Schultz TR, Thomas A, Chamberlain JM. Improving Low Acuity Patient Flow in a Pediatric Emergency Department: A System Redesign Using Improvement Science. *Pediatr Qual Saf* 2018;3:e122.

Received for publication April 3, 2018; Accepted October 10, 2018.

Published online December 6, 2018.

DOI: 10.1097/pq9.000000000000122



are operating at or above capacity.<sup>1</sup> The ED serves an important role as a safety net for underserved communities.<sup>2,3</sup> This commitment increases the demand for ED space, and so most EDs report crowding at some point during the day.

Crowding can compromise the quality of care and patient safety in addition to patient satisfaction.<sup>4</sup> This problem has become so acute that wait time and lengths of stay (LOS) have become 2 of the 5 preferred metrics for evaluating ED quality of care. The Centers for Medicaid and Medicare Services identified 5 ED crowding-related measures: patient ED time from arrival to departure for discharged patients, patient ED arrival time to departure (from ED) for admitted patients, door to doctor time, patient left without being seen rate, time from admit decision time to time of departure from ED.<sup>5</sup>

Overcrowding is not a fixed component of daily ED operations, but a problem that can and should be addressed. There is widespread agreement that improving the flow of patients in the ED and throughout the hospital holds promise for mitigating ED crowding. Patient flow improvement strategies include quick bedside registration, centralized patient tracking, effectively parsing nonemergencies from emergencies, and deploying a

clinician in triage to provide a rapid medical evaluation at certain high-volume hours of the day.<sup>6</sup>

Although much of this work focuses on patients with major severity or acuity, recent work demonstrates that focusing improvements in timeliness on low-acuity patients creates positive effects on timeliness for all patients.<sup>7</sup> This focus is important in pediatrics because we generally see a lower severity case mix than our adult counterparts.<sup>8</sup> In our ED, for example, 55% of patients are Emergency Severity Index (ESI) 4 or 5. Therefore we performed this quality improvement (QI) work to decreased ED crowding by improving the flow of these low-acuity patients.

The timing of our project correlated with organizational readiness for change. Our hospital is continually striving to improve our services. In the 2 years before this project, hospital leadership noted a failure to move the needle on patient satisfaction scores. We partnered with our service excellence team to decide how best to focus our efforts, given our limited ED space. Based on comments from satisfaction surveys, improving the wait time from initial presentation to seeing the medical provider and LOS were targeted as the interventions most likely to have the greatest impact on the outcome metric of patient satisfaction.

### *Specific Aims*

The purpose of this project was to report the initiatives implemented at a tertiary pediatric ED to improve patient flow and the impact of these QI strategies. Our specific SMART aims were to decrease arrival to provider time by 15% and LOS by 5% for low-acuity patients defined as ESI level 4 or 5.

## **METHODS**

We conducted this QI project at an urban, academic tertiary care hospital, and level 1 trauma center with more than 90 000 annual ED visits. ED medical providers include board-certified pediatric emergency medicine physicians, general pediatricians, pediatric residents, physician assistants, and nurse practitioners. Low-acuity patients presenting to the ED triaged as ESI level 4 or 5 were the target population.

We used Lean methodology to develop our strategy, specifically a Kaizen event in July 2016. Kaizen is a large scale performance improvement team brainstorming session over 5 days. We identified specific barriers to efficient patient flow process and identified the following areas as top target interventions: increased MD/RN staffing to address the volume of patients, front-end (FE) redesign, provider in triage, and improved triage assessment process. Because 57% of our low-acuity patients arrive between 1 PM and 11 PM, we focused on this period for our QI initiative. This project was undertaken as a QI initiative at Children's National Health Systems, and it does not constitute human subjects

research, as such it did not require review by the institutional review board.

### *System Redesign and PDSA Cycles*

We used the model for improvement for system transformation. A key driver diagram was used to translate the high-level improvement goals into a pictorial roadmap of the constituent goals and communicate to our stakeholders what we were testing. The final key driver diagram that served as our theory to guide testing is presented below (Fig. 1, key driver diagram).

The implementation team identified goals and strategies, planned the approach, estimated time and expenses involved with the strategy, and identified performance metrics. Nurse educators were instrumental in disseminating information to the staff and collecting weekly feedback for subsequent PDSA cycles of improvement. We conducted multiple sequential PDSA cycles to study and optimize the new triage and nursing assessment processes, patient flow, and care delivery. Teams met weekly to evaluate real-time feedback from frontline care providers and to plan the next PDSA cycles. The teams implemented successful interventions. Senior hospital leaders assisted with the acquisition of resources. A performance improvement specialist facilitated the data analyses.

## **INTERVENTIONS**

### *FE Space Redesign*

As part of an ongoing renovation of the ED to obtain additional patient care space, we reduced the waiting room space by approximately half to expand the previous 2 registration booths and 3 assessment rooms to create 3 registration desks and 7 assessment rooms. Assessment rooms were equipped to allow complete physical examinations of patients by medical providers simultaneous with nurse assessments. FE staff received computers on wheels to increase mobility.

### *Implementation of a New FE Patient Triage and Assessment Process*

A pivot nurse stationed in front of 2 registration desks greeted all new patients and obtained a quick triage with basic information (Fig. 2). Locating the pivot nurse between 2 registrars allowed the nurse to pivot between 2 patients and processing patients in pairs. Pivot nursing documentation was shortened to allow a quick assessment of a patient complaint and medical history. The patients were partially registered (name and date of birth) to allow entry into the electronic health record (EHR). After the pivot triage, patients deemed ESI 4 or 5 were evaluated in the new assessment rooms if a medical provider was available. These new assessment rooms were used in addition to the standard fast track rooms.

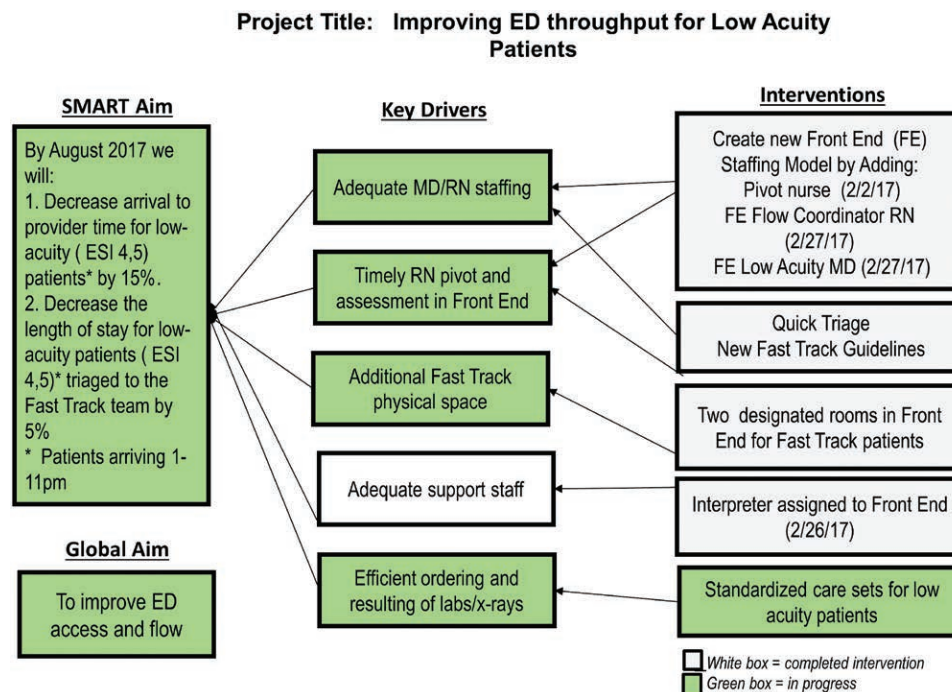


Fig. 1. Key driver diagram.

### *Adequate MD/RN Staffing*

We created a new medical provider (MD, NP or PA) shift to accommodate our high volumes of low-acuity patients. Based on arrivals per hour, this shift was from 1 PM to 11 PM Sunday through Friday and was labeled the FE low acuity shift. The FE low acuity provider treated and discharged directly from the assessment rooms. A nurse was designated FE flow coordinator to supervise overall patient flow and troubleshoot.

### *Measures*

We used the EHR to quantify all metrics. Our primary process measures were arrival-to-provider time and LOS for low-acuity patients. These measures served as a proxy for the outcome measure of patient satisfaction. Our balancing measures were (1) the rate of return to the ED within 72 hours and (2) arrival to provider times for high-acuity patients. We used statistical process control methodology to measure the effects of our interventions over time. We performed a secondary analysis to measure the response of wait times to total daily volume comparing preintervention to postintervention.

### *Data Collection*

We extracted all data from the electronic medical record and ED tracking system (Cerner FirstNet, Cerner Corporation, Kansas City, Mo.). Data for ESI 4 or 5 patients were obtained each week retrospectively and included time of arrival, time of assessment, time seen by a provider, and the total LOS. Time from assessment to the provider was calculated by subtracting the time of arrival from time seen by a provider. Patients missing any

of these data points in the EHR, or those patients arriving before 1 PM or after 11 PM were excluded from this analysis. Consistent with our usual practice, we excluded patients with an arrival to MD time more than the 95% weekly percentile and patients with an LOS exceeding 480 minutes. These patients generally represent computer errors or human error in failing to remove patients from the tracking board.

### *Analysis*

Analysis was performed using statistical process control methods. Specifically, we developed and updated annotated control charts (I charts) weekly for process measures using software package QICharts V.2.0.23 (Process Improvement Products, Austin, Tex.) for Microsoft Excel 2013 (Microsoft). The I chart was selected as it allowed for best learning about our particular system. Due to the very high number of weekly data points, the Xbar S chart did not provide the same opportunity for data analysis.<sup>9</sup> The I charts were developed to measure arrival to provider times and LOS. The initial control limits and center line (mean) were calculated using baseline data for outcome measures. The center line of an I chart comprises the average of the individual data values and so provides mean, not median data. Standard industrial criteria for special cause and system shift were used to determine if observed changes in measures were due to a specific assignable cause. For example, we identified a system shift if 8 consecutive measurements were persistently above or below the mean. New control limits and center line were calculated if a system shift was observed. A p-chart was developed to assess the balancing measure.

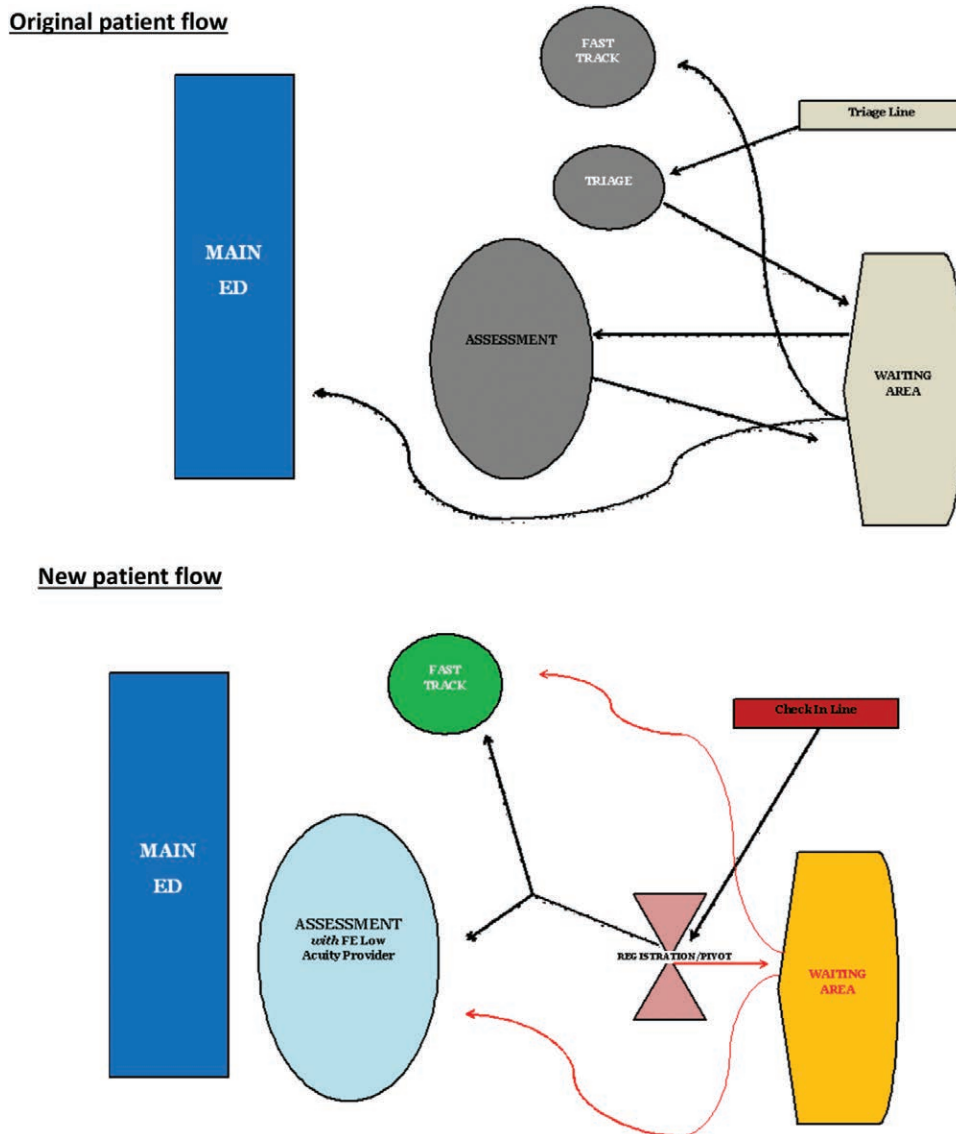


Fig. 2. Original and new patient flow diagram.

To assess the impact of interventions on wait-time response to daily volumes, we created scatterplots of wait times versus daily volume both before and after the interventions.

## RESULTS

### Process Measures

**Arrival to Provider.** During the baseline summer period (July 2016 to mid-September 2016) before interventions, ESI level 4 or 5 patients had mean arrival-to-provider times of 62 minutes. Implementation of the new flow process resulted in a decrease in arrival to provider times to 39 minutes (34% decrease, Fig. 3). Implementation of these improvements in low-acuity flow patients was not associated with a delay in wait times for high-acuity patients.

During the baseline winter period (September 2016 to March 2017) before interventions, ESI level 4, 5 fast

track patients had mean arrival to provider times of 84 minutes. Implementation of the new process resulted in a decrease to 78 minutes, a decrease of 7% in total arrival to provider times for ESI 4, 5 fast track patients in June to September 2017 (Fig. 3).

ED patient volumes are subject to seasonal changes, with wait times increasing as daily volumes increase. **Supplemental Digital Content 1** (<http://links.lww.com/PQ9/A55>) demonstrates an improvement in the response curve of wait times to daily volume comparing preintervention to postintervention. The curve for the postintervention cohort is shifted to the right and has a lesser slope compared with that of the preintervention cohort, indicating an increased capacity for managing high volumes. For example, a daily volume of 75 low-acuity patients was associated with approximately 85 minutes arrival to provider time during the baseline period compared with only 45 minutes after the FE intervention

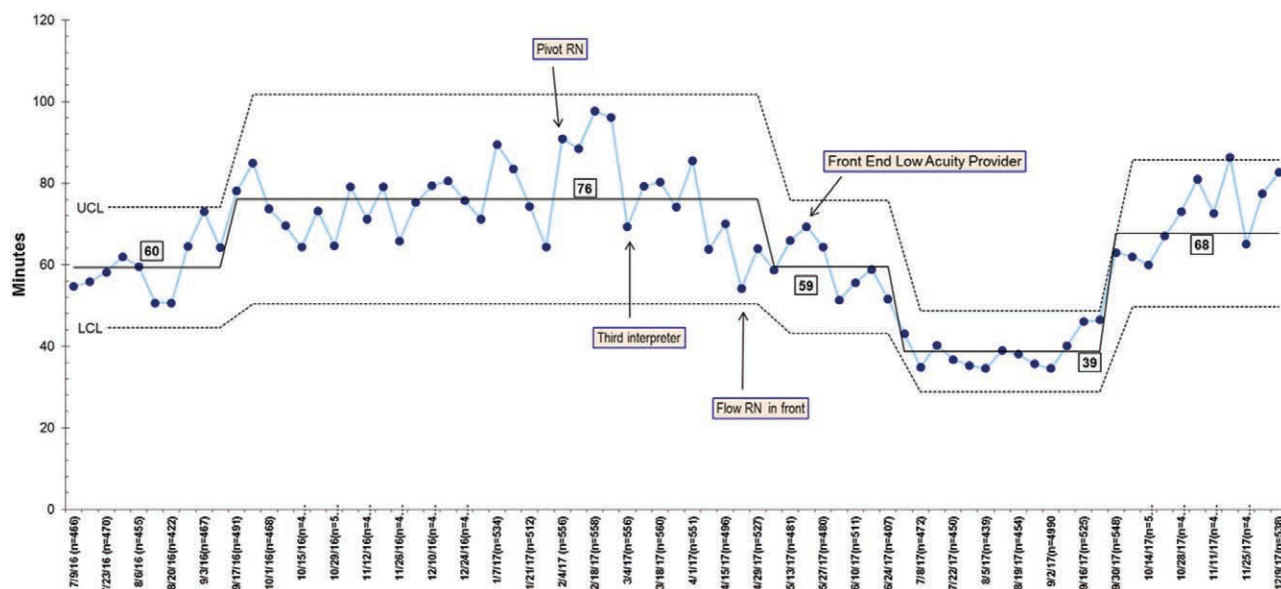


Fig. 3. I chart: arrival to provider times.

period. Before the intervention, 24% of the variance was related to daily volume. The postintervention variance was only 5%.

### LOS

During the baseline summer period (July 2016 to mid-September 2016) before interventions, ESI level 4 and 5 fast-track patients had a mean LOS of 118 minutes (Fig. 4). Implementation of the new flow process resulted in a 9% decrease in LOS for ESI 4 and 5 fast-track patients bringing the mean LOS down by 11 minutes to 107 minutes during this period.

During the baseline winter period (September 2016 to March 2017) before interventions, ESI level 4, 5 fast-track patients had a mean LOS times of 153 minutes. No gains were appreciated in the total LOS times for ESI 4, 5 fast-track patients from mid-September to date, through the end of December 2017 (Fig. 4).

### Balancing Measures

Supplemental Digital Content 2 (<http://links.lww.com/PQ9/A56>) demonstrates that the returns within 72 hours have remained stable since the start of the new flow process. Implementation of these improvements in low-acuity flow patients was associated with a 4-minute decrease in median arrival to provider times for high-acuity patients and therefore did not have a deleterious effect on these patients (data not shown).

## DISCUSSION

In this study, we describe an approach to improve the throughput for low-acuity ED patients using improvement science methodology. Much of the literature on adult ED patient flow focuses on patients with major

acuity. Gaps persist in translating these findings into pediatrics, where severity case mix is lower than in adults. Our improvement study describes a successful strategy of mitigating FE delay and improving metrics for low-acuity pediatric patients. We did this through identifying our improvement context and important factors, identifying the people and teams involved, providing a detailed map of the redesigned system, promoting the reality that 55% of our total volume is low acuity, and learning from both successful and unsuccessful testing. The effects of these interventions persist beyond the temporary testing period.

Through a comprehensive understanding of barriers to low-acuity pediatric patient flow, we developed an institution-specific patient flow improvement process through multidisciplinary team consensus and literature review. Then, using the model for improvement and sequential PDSA cycles, we redesigned the FE system for reliably expedited care of low-acuity ED patients. Systematic implementation of new triage process and additional staff produced a notable decrease in ESI 4, 5 patient arrival to provider times and overall LOS. Although these measures worsened with higher volumes, the response to volume was blunted significantly.

Since improvement is an ongoing endeavor, our next steps will include improving the methodology to deliver consistently even during extremely high-volume periods, such as seasonal influenza pandemics. Another challenge for all improvement work is the sustainability of the processes that led to better outcomes. To enhance sustainability, we have a multidisciplinary team that monitors weekly throughput metrics. The team is devising triggers for action if special cause is observed. The team also continues to seek ongoing modifications to sustain the gains in patient care.

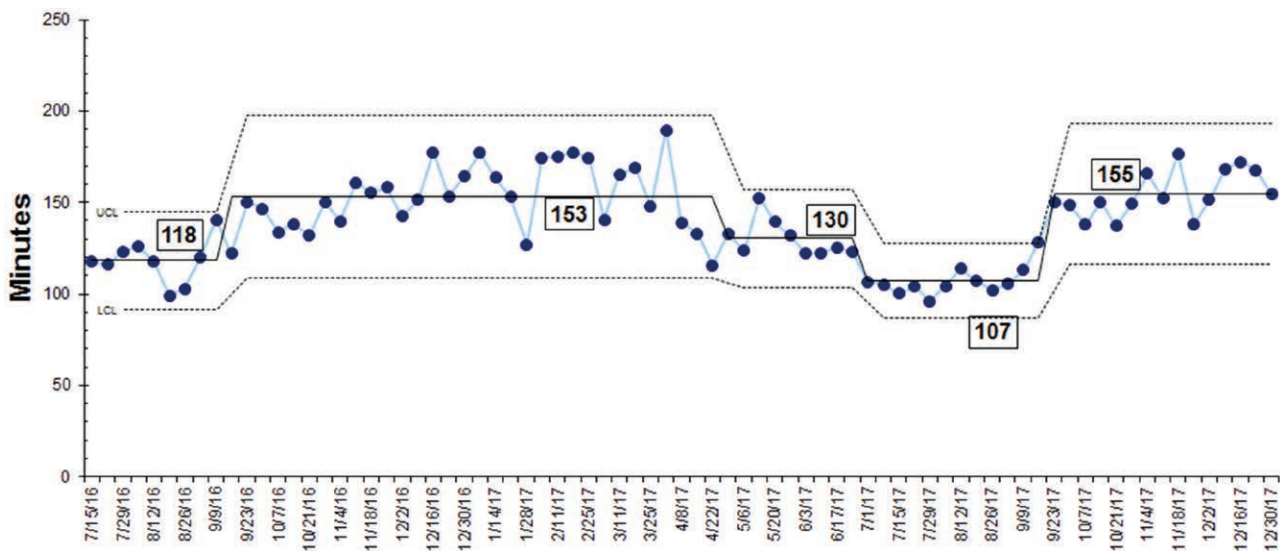


Fig. 4. I chart: length of stay.

**Limitations**

Our work has several limitations. We performed this improvement work at a single pediatric center with a culture of continuous improvement. Our interventions were selected based on our local system failures, which may vary in other healthcare environments. Our institutional culture and resources supported successful implementation but may pose challenges in other settings. For example, we made changes to our staffing model, an intervention that many centers may not be able to implement. The estimated cost of providers alone for this trial was approximately \$300 000 annually. This expense may not be justifiable at other institutions.

**CONCLUSIONS**

We designed and implemented a QI initiative to improve the throughput for low-acuity patients presenting to a high-volume pediatric ED to help decrease overall crowding. Our QI efforts were associated with an approximate 34% reduction in arrival to provider rates and 5% decrease in LOS times during the summer months without a concurrent increase in 72-hour readmission. Careful comparisons to similar time frames in prior years and assessment of volumes support our conclusion that the reduction we observed was related to our QI efforts and not the result of lower volumes. The challenge will be to maintain these gains in the setting of high-volume winter months. With up to one-half of children presenting to pediatric emergency centers triaged as low acuity, further QI work in this area is important.

**ACKNOWLEDGMENTS**

The authors acknowledge the active participation of the following team members in this improvement project: Amy Stuhlfauth, RN; Jaclyn Tapia, RN.

**DISCLOSURE**

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

**REFERENCES**

1. American Academy of Pediatrics Committee on Pediatric Emergency Medicine. Overcrowding crisis in our nation’s emergency departments: is our safety net unraveling? *Pediatrics*. 2004;114:878–880.
2. Gordon JA, Billings J, Asplin BR, et al. Safety net research in emergency medicine: proceedings of the Academic Emergency Medicine Consensus Conference on “the Unraveling Safety Net.” *Acad Emerg Med*. 2001;8(11):1024–1029.
3. Ong Eng Hock M, Ornato JP, Cosby C, et al. Should the emergency department be society’s health safety net? *J Public Health Policy*. 2005;26:269–281.
4. Sills MR, Fairclough D, Ranade D, et al. Emergency department crowding is associated with decreased quality of care for children with acute asthma. *Ann Emerg Med*. 2011;57:191–200.e1.
5. Chang AM, Lin A, Fu R, et al. Associations of emergency department length of stay with publicly reported quality-of-care measures. *Acad Emerg Med*. 2017;24:246–250.
6. Lynn-Green E, Arjun Venkatesh A, Forman H. Strategies to improve care in the emergency department—the De Facto Multispecialty Clinic of the 21st century. *Health Management Policy and Innovation*. 2017;2(2).
7. Iyer S, Gallagher P, Buncher M, et al. Fast track: designing the system to perform as the name suggests, IHI Scientific Symposium, 2010.
8. Barata I, Brown KM, Fitzmaurice L, et al.; American Academy of Pediatrics Committee on Pediatric Emergency Medicine; American College of Emergency Physicians Pediatric Emergency Medicine Committee; Emergency Nurses Association Pediatric Committee. Best practices for improving flow and care of pediatric patients in the emergency department. *Pediatrics*. 2015;135:e273–e283.
9. Provost L, Murray S. *The Health Care Data Guide: Learning from Data for Improvement*. San Francisco, Calif.: Jossey Bass; 2011.