

# A Quality Improvement Initiative to Improve the Administration of Systemic Corticosteroids in the Pediatric Emergency Department

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## Abstract

**Introduction:** Timely administration of corticosteroids improves asthma care in the pediatric emergency department (ED). Using the Model for Improvement, we aimed to decrease time to delivery of corticosteroids in patients presenting to the ED with an acute asthma exacerbation. **Methods:** This is a single-center, prospective, multidisciplinary quality improvement (QI) project targeting ED patients 1–18 years of age with an acute asthma exacerbation. We collected 5 months of baseline data from the arrival time of an ED patient with an asthma exacerbation with a Modified Pulmonary Index Score  $\geq 5$  to the time of administration of corticosteroids. A quality improvement project was launched in October 2017 involving multiple Plan-Do-Study-Act ramps. Improvement interventions continued for 9 months through June 2018, including reeducation of residents and nurses in the ED asthma order set and nursing treatment protocols, respectively, and changes to the electronic health record. Data were tracked for 15 additional months until September 2019. To promote the use of the nursing treatment protocol, we utilized real-time improvement feedback and continuing nursing education. **Results:** The mean percentage of patients receiving steroids within 60 minutes of arrival improved from 59.3% to 84.3% over the first 5 months. The mean time to the administration of steroids within 60 minutes of arrival improved from 71.4 to 48.1 minutes. There was no increase in ED return rates. **Conclusions:** Our project improved the percentage of patients with acute asthma exacerbations receiving steroids within 60 minutes of ED arrival and mean time to administration of steroids. We sustained improvement for 18 months after the implementation of our QI interventions. (*Pediatr Qual Saf* 2020;5:e308; doi: 10.1097/pq9.0000000000000308; Published online June 8, 2020.)

## INTRODUCTION

Pediatric asthma is a common chronic disease affecting almost 9 million children in the United States.<sup>1</sup> In 2009, 679,000 children with acute asthma were treated in the emergency department (ED) or admitted to the hospital.<sup>2</sup> National Heart, Lung, and Blood Institute asthma guidelines support the use



of corticosteroids in moderate-to-severe asthma exacerbations.<sup>3</sup> Prior studies demonstrate that nurse-initiated corticosteroids in triage, before physician assessment, decrease the rate of return to the ED and decrease ED length of stay (LOS).<sup>4–6</sup> Compared with albuterol delivery, a previous study supports early glucocorticoid administration, which is associated with improved ED asthma patients.<sup>7</sup> Additionally, the use of nurse-initiated protocols in triage has led to improvements in ED

flow in infants with hyperbilirubinemia, sepsis, and application of topical anesthetics to lacerations.<sup>8–10</sup>

A previous retrospective chart review of 4,300 patient visits to our ED showed that the average time to systemic corticosteroids for patients with an acute asthma exacerbation was 93 minutes, and only 50% of these patients received systemic corticosteroids in less than 60 minutes.<sup>11</sup> A published retrospective review from our institution demonstrated that administering corticosteroids to pediatric asthma patients in the ED within 1 hour of triage is associated with a 25-minute mean decrease in LOS.<sup>6</sup> With large numbers of asthma visits, a 25-minute reduction in LOS for each child could have a significant impact on patient throughput in the ED. Previous quality improvement projects have improved asthma care by increasing the timely use of asthma scoring tools and delivery of short-acting beta-agonists.<sup>12</sup>

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Using continuous quality improvement methods, we aimed to optimize the utilization of our asthma nursing treatment protocol (NTP) and ED asthma pathway by ED nurses and providers to improve the timely delivery of systemic corticosteroids in patients with an acute asthma exacerbation. The global aim of our project was to improve the overall quality and timeliness of acute asthma care in our ED. Our specific aim was to increase the percentage of patients eligible for the ED asthma pathway with an initial Modified Pulmonary Index Score (MPIS) (Table 1)  $\geq 5$  who received systemic corticosteroids within 60 minutes of arrival from a baseline rate of 59.3% to a goal of 90% within 8 months of initiation of our quality improvement project. Secondary aims included decreasing both ED LOS and hospital admission rates for ED patients with an acute asthma exacerbation.

## METHODS

### Study Setting

Our ED is part of an academic urban children's medical center with an annual volume of over 60,000 patients. The ED is staffed by pediatric emergency physicians 24 hours a day, as well as pediatric emergency fellows, pediatric, emergency medicine and family practice residents, and advanced practice providers. The ED has dedicated nursing staff with support from respiratory therapists. Our institution implemented an asthma ED clinical pathway and a stand-alone NTP in October 2014 (Fig. 1) that standardizes the care of ED patients with an acute asthma exacerbation. Despite this, timely initiation of acute asthma care was sporadic.

Quality metrics are monitored monthly for the pathway, and the pathway undergoes an annual review by our institution's Clinical Effectiveness Committee. Asthma care on the pathway is directed by the patient's MPIS (Table 1), a standardized and validated asthma scoring system.<sup>13</sup> The asthma pathway directs ED providers to give oral corticosteroids to any patient over age 1 with a known history of asthma or 2 or more past episodes of wheezing with an initial MPIS of  $\geq 5$ . A standardized

ED asthma order set within the electronic health record (EHR) supports our asthma pathway. Nurses can deliver the initial care of our ED asthma pathway using the NTP before an ED provider evaluates a patient. This treatment protocol consists of orders that allow nurses to initiate treatment for a patient with acute asthma exacerbation in patients with a known history of asthma or 2 or more episodes of past wheezing. These standing orders consist of placing a patient on a complete cardiorespiratory monitor, calculating an initial MPIS, administering supplemental oxygen if needed, administering nebulized albuterol and ipratropium or albuterol by metered-dose inhaler depending on the patient's initial MPIS, and giving oral dexamethasone for an initial MPIS  $\geq 5$ .

### Study Subjects

Patients were included in the project if they met criteria for the ED asthma clinical pathway: age 1–18 years, a history of asthma or 2 or more past episodes of wheezing, and an initial MPIS  $\geq 5$ . Patients were excluded from analysis if they had significant comorbid medical conditions such as other chronic pulmonary diseases, congenital heart disease, neuromuscular disease, patients who were immunocompromised or immunosuppressed, patients on chronic systemic steroids, or any patient who had received systemic steroids within the last 48 hours.

### Interventions

We convened a multidisciplinary ED improvement team comprised a pediatric emergency medicine physician, a pediatric emergency medicine fellow, a pediatric resident, an ED nurse educator, ED staff nurses, a hospital quality improvement analyst, and a hospital information technology specialist. Both the ED physician and nursing leadership supported the project. We used the Model for Improvement to plan each step and implement changes.

Components of the project quality improvement bundle are highlighted in Table 2. Key process improvements included reeducation of resident physicians rotating through the ED and nurses on the asthma clinical pathway and the goal to administer corticosteroids early in

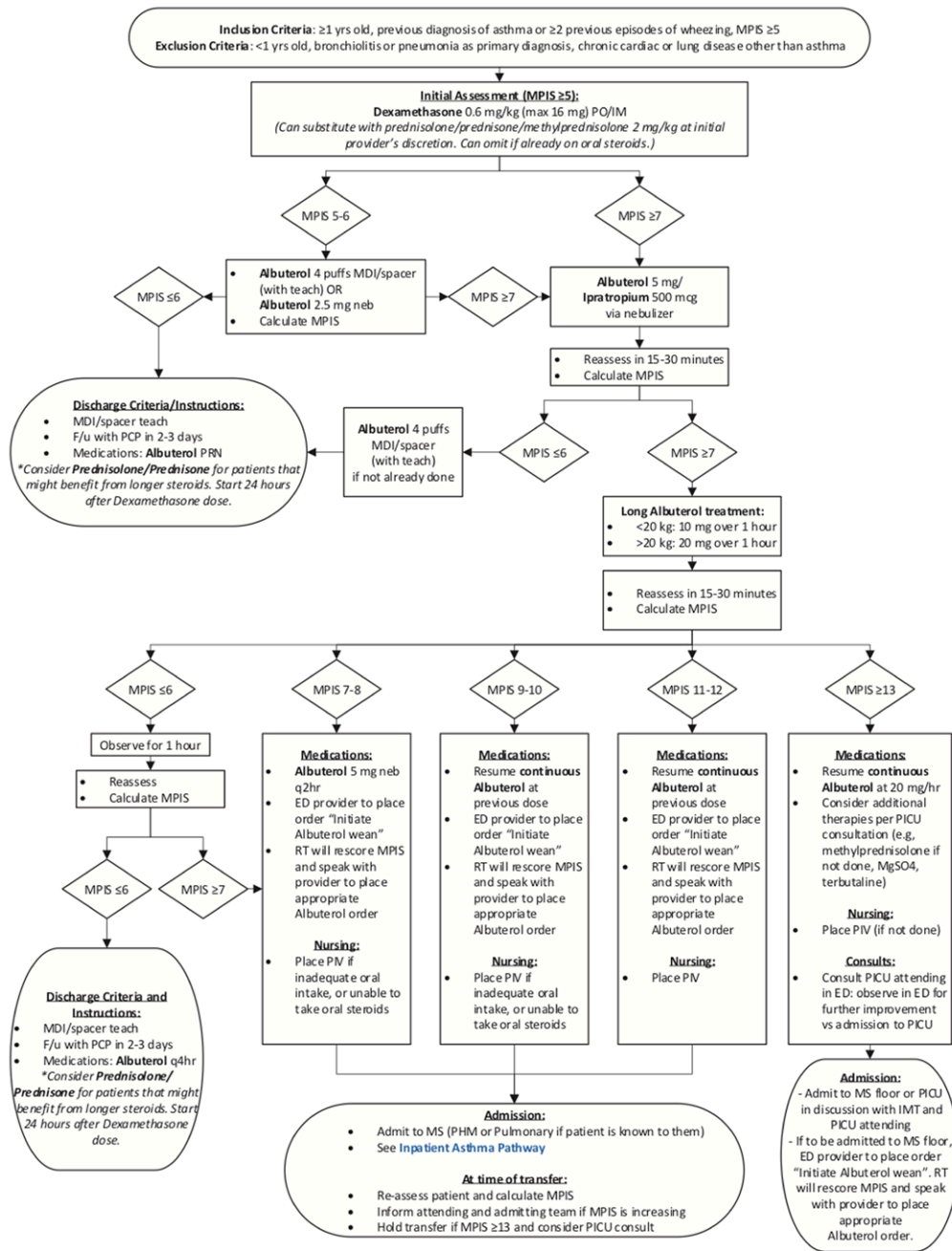
**Table 1. The Modified Pulmonary Index Score**

Category	Score			
	0	1	2	3
Oxygen saturation, %	>95	93–95	90–92	<90
Accessory muscle use	None	Mild	Moderate	Severe
Inhalation-exhalation ratio	2:1	1:1	1:2	1:3
Wheezing	None	End expiratory	Inspiratory and expiratory wheeze, good aeration	Inspiratory and expiratory wheeze, decreased aeration
Heart rate, /min				
<3 years old	<120	120–140	141–160	>160
$\geq 3$ years old	<100	100–120	121–140	>140
Respiratory rate, /min				
<6 years old	$\leq 30$	31–45	46–60	>60
$\geq 6$ years old	$\leq 20$	21–35	36–50	>50

Six categories are evaluated: (1) oxygen saturation on room air, (2) accessory muscle use, (3) I:E ratio, (4) wheezing, (5) heart rate, and (6) respiratory rate. For each measurements or observations, a score (0 to 3) is assigned, resulting in a minimum score (0) and a maximum score (18). I:E, inhalation exhalation; EMR, electronic medical record.

# CLINICAL PATHWAY: Emergency Department Asthma

THIS PATHWAY  
SERVES AS A GUIDE  
AND DOES NOT  
REPLACE CLINICAL  
JUDGMENT.



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**Fig. 1.** Emergency department asthma pathway for acute asthma exacerbations. po, by mouth; IM, intramuscular; MDI, metered dose inhaler; f/u, follow-up; PCP, primary care physician; PIV, peripheral IV; RT, respiratory therapist; PICU, pediatric intensive care unit; IMT, inpatient medical team; MS, medical-surgical; PHM, pediatric hospital medicine.

the ED course. The improvement team created an educational document that reviews the pathway and how to use

the ED asthma order set in the EHR. The document was trialed and revised using Plan-Do-Study-Act cycles. Once

**Table 2. Quality Improvement Bundle Components**

Quality Improvement Bundle Components
Reeducation of resident physicians and ED nurses of the asthma pathway and importance of early administration of steroids
Development of an educational document emailed to rotating residents
Development of an educational document for nurses encompassing the ED asthma pathway and ED asthma NTP
Nursing review at huddles twice daily
Nursing education on NTP in annual nursing validations
EMR changes to NTP and chief complaint links to asthma pathway
Weekly feedback to the nursing staff using data management system board and email updates

revised, it was emailed to all residents before the start of their 4-week ED rotation. The team distributed the same educational document to the entire pediatric residency at the beginning of the project.

The team created a separate educational document for nursing staff, encompassing the ED asthma clinical pathway and ED asthma NTP. Again, we revised the document by testing the document with nursing leadership and staff nurses using Plan-Do-Study-Act cycles. This document was sent to all nursing staff via email and was reviewed during routine nurse staff meetings. Staff reviewed the details of the project at twice daily ED staff huddles attended by all staff. We also included education on the NTP in annual nursing validations, ongoing educational modules required to be completed by all nursing staff in April 2018.

Additionally, 2 changes were made to the EHR to encourage the use of the ED asthma NTP by ED nurses. First, expanded chief complaints entered by nursing staff during patient triage were linked to the ED asthma NTP in the EHR. In the past, only asthma, wheezing, and respiratory distress would automatically trigger a suggestion to use the asthma NTP. We added the chief complaints of cough and shortness of breath. The second change moved the nursing calculator for the MPIS from an inaccessible area in the EHR, which required multiple steps to access the main toolbar on the main nursing screen. This change aimed to make it easier for nursing staff to use and calculate an MPIS. These changes were tested and revised in the testing area of the hospital EHR before final implementation.

Finally, weekly feedback was given to the nursing staff on the progress of the project. We displayed data from the project on the ED data management system board in the ED, near where twice daily ED huddles were held. Weekly emails reviewing real-time data were sent to all nursing staff that highlighted project successes and specific case failures. Emergency medicine attending physicians, fellows, and advanced practice providers were informed of the project by email and during a routine staff meeting before initiating the project.

### Measures

Baseline data were extracted from an existing quality database tracking metrics of the ED asthma clinical

pathway for 6 months, from May 2017 through October 2017. Active improvement work began with the project's announcement at the end of October 2017 and continued through June 2018. Ongoing monitoring continued during our sustainability phase through the end of September 2019. Data points collected included patient age, sex, initial MPIS recorded in the medical record, time from arrival to administration of systemic corticosteroids, patient ED LOS, and patient disposition from the ED. The process measure for our initiative was the percentage of patients with asthma exacerbations receiving steroids within 60 minutes of ED arrival. Any patient who received steroids >60 minutes from ED arrival underwent a manual chart review to determine if there was a reason for the delay in steroid administration that would exclude the patient from the ED asthma clinical pathway or asthma NTP. We also tracked overall mean time to steroid administration. Time to steroid delivery was defined as the time from the patient's arrival in the ED, time of the first contact with registration during ED triage, to the time of medication administration documented in the EHR. Secondary outcomes measured were overall ED LOS and hospital admission rates. We defined ED LOS as the time from ED arrival to final disposition. We reviewed ED returns within 48 hours of the initial visit as a balancing measure.

### Analysis

Data for the percentage of patients receiving steroids in ≤60 minutes and mean time to steroids were plotted monthly on statistical process control charts for analysis using Microsoft Excel. We plotted mean shifts after 8 consecutive data points above or below the mean with an identifiable cause, signaling special cause.<sup>14</sup> Control limits for statistical process control charts were 3 SDs. Comparison of demographic characteristics and ED LOS was calculated utilizing a comparison of means *t* test for age and initial MPIS. For sex, we calculated the *P* value using a Chi-square test. Statistical significance was accepted at *P* < 0.05 for all analyses.

### Ethical Considerations

The project was considered quality improvement and not human subject research. Therefore, it did not require review and approval by the institutional review board.

## RESULTS

From May 2017 to September 2019, 1,775 patient encounters met criteria based on their initial MPIS score in the pediatric ED. There were 373 patient encounters during the baseline period and 1,402 patient encounters after the start of our quality improvement interventions. Pre- and postintervention patient populations were similar in age, sex, and initial MPIS (Table 3).

At baseline, 59.3% of eligible patients received steroids within 60 minutes of ED arrival. After initial educational

**Table 3. Demographic Data of Pre- and Postintervention Groups**

	Preintervention (n = 373)	Postintervention (n = 1402)	P
Age (median)	4 (6)	4 (6)	0.71
Sex; Male	232 (62.2%)	813 (58.0%)	0.14
First MPIS	8.3 (SD = 2.6)	8.3 (SD = 2.6)	1.00

initiatives of our project in January 2018, there was a shift in mean percentage to 68.3% of patients receiving steroids within 60 minutes of arrival. With the completion of our interventions, the mean rate of patients receiving steroids within 60 minutes increased to 84.3% in March 2018 (Fig. 2). Sustained improvement continued for 18 months through September of 2019. The weekly mean time from ED arrival to steroid administration improved from a baseline of 71.2 minutes to 39.4 minutes following our interventions (Fig. 3). We sustained this improvement through September 2019.

ED LOS decreased over the intervention: 254 to 238 minutes for all patients ( $P = 0.10$ ) and 208 to 196 minutes for patients discharged from the ED ( $P = 0.06$ ). For patients admitted to the hospital, there was no change in ED LOS (347 minutes).

Finally, there was an overall decrease in admission rates for patients with moderate-to-severe asthma exacerbations in our ED. Admission rates decreased from 32.7% of ED asthma patients to 27.9% ( $P = 0.007$ ). As a balancing measure, our return to ED within 48 hours of the previous visit for acute asthma remained constant at 2% pre- and postinterventions.

## DISCUSSION

Our quality improvement project demonstrated significantly improved time to administration of corticosteroids to ED patients with acute asthma exacerbations. Our rate of 84.3% of patients receiving steroids in  $\leq 60$  minutes from ED arrival nearly met our goal of 90%; we surpassed our goal of 90% for many months. Our improvement was sustained for over 18 months. In February 2019, we saw special cause variation with a data point outside of our control limits with both a decrease in the percentage of patients receiving steroids within 60 minutes of ED arrival and with a marked increase in our mean time to steroid administration. During this month, our ED had a significant increase in the daily census, with volumes often over 150% of our daily average. We hypothesize that this increase in volume directly led to delays in steroid administration. This possibility is supported by past work by Bekmezian et al<sup>15</sup> that demonstrated that delayed corticosteroid administration could be affected by ED crowding. The second point of special cause variation outside of the upper control limit occurred for mean time to steroids in May 2019. Still, the percentage of patients receiving steroids within 60 minutes remained within the control

limits. We hypothesize that this resulted from 3 of the 71 patients that month who had a substantial delay in steroid administration that skewed the mean data. On a manual chart review, we could not identify factors that lead to delays in these patients.

Both overall ED LOS and ED LOS for discharged patients improved but did not reach statistical significance. We suspect that many other variables affect ED LOS, including daily volume, ED crowding, type of primary ED provider, ED staffing, among other factors. A large group of admitted patients may have driven the lack of significant change in overall ED LOS for all patients. In this cohort, there were several very prolonged LOS ( $>600$  minutes) in our postintervention group. These patients were likely “boarding” in our ED while awaiting an inpatient bed.

Systemic corticosteroids are essential to the management of acute asthma exacerbations.<sup>3</sup> Additionally, clinical pathways can help improve asthma management for children with acute asthma exacerbations.<sup>16,17</sup> It has been previously established that NTPs can reduce ED LOS and the rate of return to the ED.<sup>4,5</sup> Furthermore, when nurses initiate clinical pathways for asthma in the ED, asthma care improves in the ED.<sup>18</sup> Bhogal et al<sup>19</sup> demonstrated that early administration of systemic corticosteroids could reduce admission rates for children with acute asthma exacerbations, which is in line with our 4.8% decrease in hospital admission rate for patients with asthma postintervention.

Before beginning our project, we identified barriers for nurses and providers in ordering corticosteroids for patients. Some nurses believed that the established nursing protocol could only be utilized for patients with the diagnosis of asthma, even though our protocol allows for use in patients who have wheezed  $\geq 2$  times. Additionally, medical residents were unselecting corticosteroids in the pathway-specific order set in the ED EHR.

Reeducation was provided to all nursing staff at monthly nurse staff meetings and followed up by emails. Medical residents also received emails at the beginning of their ED rotation with information about the asthma pathway and the importance of systemic corticosteroids. Additionally, the review of our project progress was documented on our ED data management system board. These methods were similar to the improvement in adherence as seen by McIver et al<sup>20</sup> with signs and emails during their asthma quality improvement project.

EHR changes also contributed to our success in the project. These changes included easier access to the nurses' EHR screen to access the respiratory score as well as a link from chief complaint to the NTP. The NTP was the preexisting protocol for the administration of steroids and albuterol and ipratropium. With the introduction of these higher reliability changes to our NTP in the EHR and accessibility to the MPIS scoring tool, we saw an even more significant improvement in our percent of patients receiving steroids within 60 minutes of ED arrival. These

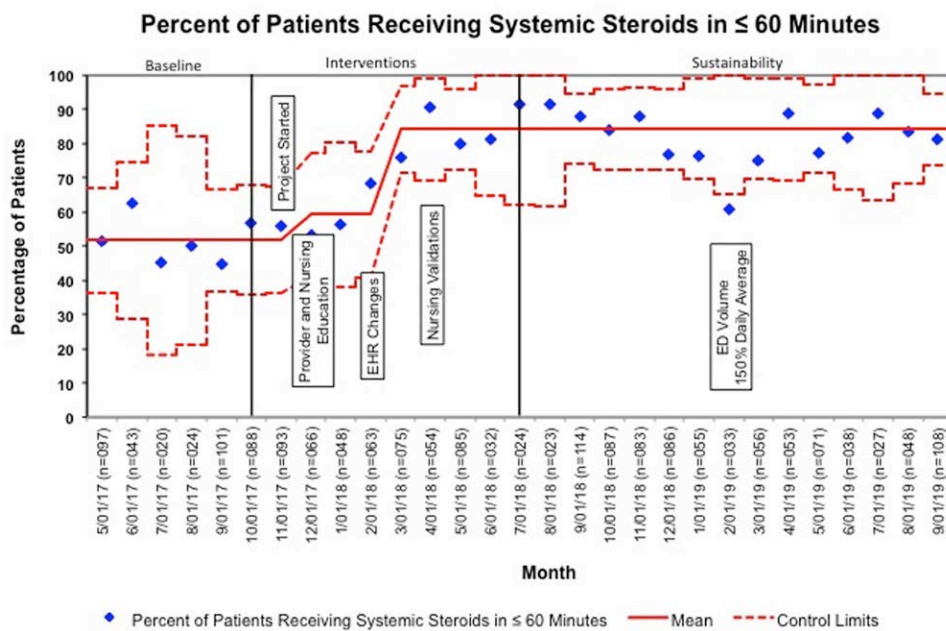


Fig. 2. Percent of patients receiving systemic steroids in ≤60 minutes.

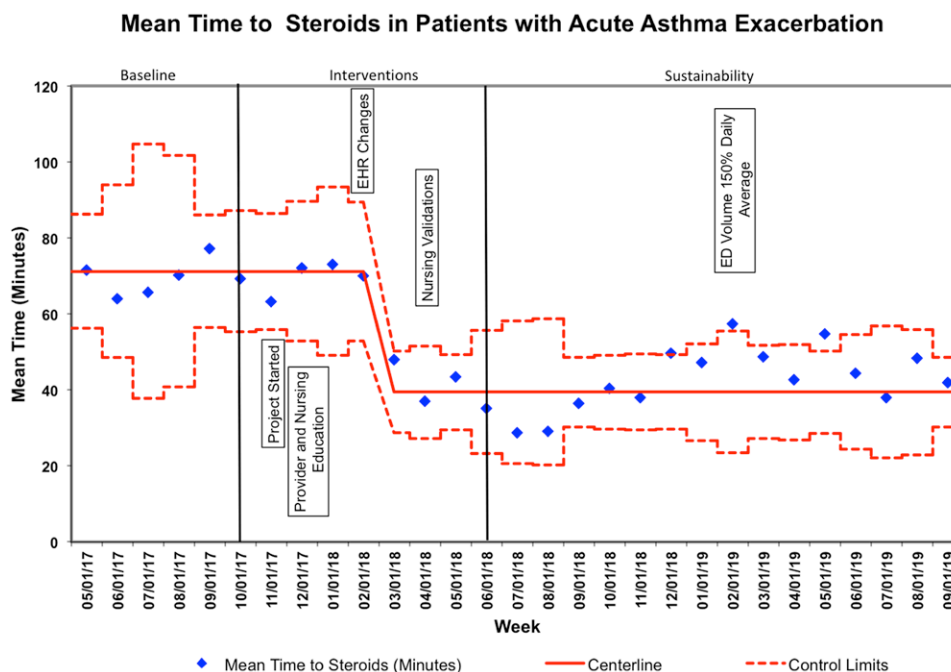


Fig. 3. Mean time to steroids in patients with acute asthma exacerbation.

system changes offer higher reliability of change compared with our initial educational interventions.

After 5 improvement cycles, significant improvement was noted. We attribute this to a combination of factors including nursing and resident reeducation, signs and emails reviewing the project, and multiple EHR changes. Ongoing monitoring took place from April 2018 to September 2019 to ensure that implemented changes were sustainable.

Limitations of our project include the project being developed and carried out at a single institution, limiting possible generalizability to other hospitals. There are seasonal variability and turnover of resident physicians monthly, which may lead to variability in the use of the asthma clinical pathway. Over time sustainable change must be reassessed by following data and providing education to new nurses and providers.

Outcome measures such as ED LOS may continue to improve if process measures can identify gaps in discharge order placement to actual ED discharge time. Additionally, for ED LOS, we are limited by this measure as true LOS and not time to disposition decision. There are likely other factors, including inpatient bed availability, that increase ED LOS.

For future work to ensure sustainability, further high-reliability interventions in the EHR may be developed that direct nurses and providers to use the NTP or asthma order set. Additionally, a best practice alert could be added to route them directly to the NTP or asthma order set. There is ongoing reeducation during nursing validations and for residents during annual lectures with pathway updates.

## CONCLUDING SUMMARY

Our project improved the percentage of patients with acute asthma exacerbations receiving steroids in under 60 minutes from ED arrival. It also improved the mean time to administration of steroids. A combination of educational components and EHR support of early steroid administration has led to the sustained improvement of corticosteroid administration in the ED.

## DISCLOSURE

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

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