

Reducing the Cranial CT Rate for Pediatric Minor Head Trauma at Three Community Hospitals

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ABSTRACT

Objective: Efforts to reduce the rate of computerized cranial tomography (CT) in pediatric patients with minor head trauma (MHT) have focused on academic medical centers. However, community hospitals deliver the majority of pediatric emergency care. We aimed to reduce cranial CT utilization in patients presenting with MHT at 3 community hospital emergency departments (EDs).

Methods: Multidisciplinary stakeholder teams at each site oversaw the quality improvement effort, which included education about an evidence-based guideline for MHT and individual provider feedback on CT rates. Given the variation in hospital structure, we tailored the specifics of the intervention to each site. We used statistical process control methodology to measure CT rates over time. The primary balancing measure was returned to the ED within 72 hours with clinically important traumatic brain injury. **Results:** We included 3,215 pediatric ED visits for MHT: 1,253 in the baseline period and 1,962 in the intervention period. The CT rate dropped from 18% in the baseline period to 13% in the intervention period, a 28% relative reduction. Pediatric providers saw 72% of the intervention period encounters and drove this reduction. There was no increase in the number of children who returned to their local ED within 72 hours with clinically important traumatic brain injury. **Conclusions:** We safely reduced the proportion of children with MHT who received a cranial CT through a multicenter community ED quality improvement initiative. We did not see an increase in missed clinically important traumatic brain injury. (*Pediatr Qual Saf* 2019;4:e147; doi: 10.1097/pq9.000000000000147; Published online March 20, 2019.

INTRODUCTION

Pediatric minor head trauma (MHT) results in >640,000 emergency department (ED) visits each year,¹ and the frequency of these visits is increasing.^{2,3} Given the risk of malignancy associated with ionizing radiation,⁴ safely reducing the utilization of computerized cranial tomography (CT) among pediatric MHT patients has been a topic of considerable research.

In 2009, the Pediatric Emergency Care Applied Research Network developed prediction rules to identify children presenting with MHT who were at a low risk of clinically important traumatic brain

injury, and in whom cranial CT could be safely avoided.⁵ These rules are sensitive and cost-effective.⁶⁻⁸ A large recent study demonstrated a reduction in cranial CTs as a result of the implementation of prediction tools in combination with clinical decision support.⁹ These prediction tools have also been adopted into evidence-based guidelines (EBGs), which, when used in combination with additional interventions such as order sets and provider feedback, have successfully reduced cranial CT rates in pediatric and community hospital EDs.¹⁰⁻¹²

Despite ongoing efforts to decrease cranial CTs for MHT, there has not been a significant decrease in the rate of CTs ordered for pediatric head trauma in the post Pediatric Emergency Care Applied Research Network head trauma study era.¹³ Furthermore, there remains significant variation in CT rates for this population. A 2010 study of >50,000 ED visits at freestanding children's hospitals found rates that varied from approximately 20% to >50%.¹⁴ Finally, cranial CT rates are significantly higher in community hospitals compared with freestanding children's hospitals.^{13,15} This finding is particularly concerning as community hospitals provide the majority of pediatric emergency care.¹⁶⁻¹⁸

We initiated a quality improvement (QI) project at 3 community hospitals affiliated with a freestanding children's hospital. As a QI effort to reduce cranial CT rates across a network of community hospitals has not been described, we aspired to provide a model for other



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hospital networks looking to institute change. We aimed to safely reduce the cranial CT rates at each of the community hospitals EDs over the 1-year study period.

METHODS

Context

This project was a year-long staggered start QI initiative at 3 community hospitals.

The community hospital had to be affiliated with the free-standing children's hospital to be eligible for participation in the QI program. Their cranial CT rate among pediatric MHT patients had to exceed that of the freestanding children's hospital. Out of the 5 affiliated community hospitals, 3 were eligible for participation (2 others had CT rates that were equivalent to or lower than that of the associated free-standing children's hospital). Henceforth, we refer to these eligible community hospitals as sites A, B, and C.

Site A has a separate 11-bed pediatric ED staffed by a combination of pediatric emergency medicine (PEM) physicians and acute care pediatricians, who provide 24-hour coverage. Site B has a general ED with a 5-bed pediatric area staffed by a combination of PEM and acute care pediatricians 12 h/d. Site C has a general ED with a 5-bed pediatric area, with 10 hours of PEM and acute care pediatrician coverage daily. General emergency medicine practitioners (ED providers who are not acute care pediatricians or PEM attendings) provide coverage when pediatric providers are not present. These 3 sites are located between 15 and 30 miles from the affiliated freestanding children's hospital, representing a drive time between 25 and 140 minutes.

Evidence-Based Guideline

We used the EBG for MHT described by Nigrovic et al.¹⁰ This guideline has been available at each site since September 2011, but the use was variable by both pediatric and general emergency medicine providers.

Generating Standardized Data Reports

To accurately assess the cranial CT rate, our priority was to create an automated and standardized data report that provided information on cranial CT usage at the institutional and provider level across 3 sites with different electronic medical records and data repositories. Reports were designed to capture ED patients who met the following inclusion criteria: (1) age 21 years or younger; (2) an International Classification of Diseases (ICD)-10 code for MHT (S06.0X0A, S06.0X1A, S06.0X2A, S06.0X9A, S09.10XA, S09.11XA, S09.19XA, S09.8XXA, S09.90XA); and (3) discharge to home from the ED. ED discharge to home was used as an inclusion criterion because the community sites did not uniformly document a Glasgow Coma Score (GCS) for MHT patients, one of the inclusion criteria in the EBG. We assumed a priori that patients with a GCS lower than 14 would have been hospitalized or transferred to a tertiary care site.

Intervention

In addition to creating data reports, we formed a team of stakeholders at each site consisting of QI leaders, clinical leadership, and pediatric physicians (acute care pediatricians and PEM physicians). Physicians were recruited to join if they wished to receive the American Board of Pediatric Maintenance of Certification part IV credit for participation. We provided stakeholders at each site with background information, including the literature supporting reduction in the cranial CT use. In the month before implementation, each team educated its local clinicians. Educational interventions were tailored to the local culture and included a combination of lectures, presentations at staff meetings, posted signs, computer banners, and emails designed to encourage the use of the MHT EBG. For an example of a computer banner used, see Figure 1.

We staggered the implementation of the intervention across sites using a 3-month interval, with the intention of learning from each site's successes and challenges as the project moved forward. Individual feedback was provided quarterly at each site: if a provider (general or pediatric) saw a minimum number of patients who met inclusion criteria, he/she received a standardized email with their individualized cranial CT rate every 3 months. The email also included a reminder of the intervention and a scatter plot of the cranial CT rates identifying the individual among anonymized peers. We allowed each site to determine the minimum number of patients a provider needed to see to get feedback (5 or 10) depending upon the site volume.

Data Measures and Collection

We collected baseline CT rate data before the intervention. Data elements included month and year of the ED visit, whether or not cranial CT was ordered, and the provider type (ie, general, pediatric PEM, and hospitalist).

The balancing measure was the failure to recognize clinically important traumatic brain injury. This measure was defined as a repeat visit to the patient's local community ED within 72 hours of discharge from the index ED visit with hospitalization for ≥ 2 nights or transfer to a tertiary care center for management of sequela from the head injury during that return visit. We gathered this information from medical record review of any patient with return visits within 72 hours.

Data Analysis

Statistical process control methods were used to track the effect of the intervention on the proportion of patients receiving a head CT for MHT over time. Control limits were set at 3 SDs from the mean. We identified common and special cause variation using standard criteria. We created a p-chart of monthly CT rates to analyze the aggregate data. We conducted 2 additional subanalyses: one looking at the data by provider type (general versus pediatric) and another looking at the data by site. Statistical Process Control (SPC) charts were constructed using SQC Pack, PQ System (Dayton, Ohio).



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Fig. 1. Computer “banner” affixed to provider computers at site A.

At all 3 sites, the project was deemed QI and not human subjects research. Therefore, it did not require Institutional Review Board (IRB) review and approval. Given the absence of any patient-identifiable elements, data use agreements were not required between the collaborating institutions.

RESULTS

We obtained 8 months of baseline data from site A, 4 months from site B, and 12 months from site C. We were unable to obtain a full year of baseline data from each site due to transitions in electronic medical record vendors. There were a total of 1,253 pediatric ED visits for MHT during the baseline period at the 3 sites: 550 at site A, 182 at site B, and 521 at site C. The baseline cranial CT rates at sites A, B, and C were 19%, 17%, and 19%, respectively. The cranial CT rate at the affiliated freestanding children’s hospital for patients with the same ICD-10 codes and GCS ≥ 14 for the year before study start was 9%.

Site A began the intervention on September 1, 2015, site B began on December 1, 2015, and site C on March 1, 2016. The intervention lasted 1 year at each site with a total study period of 18 months. During the study period,

there were a total of 1,962 encounters that met inclusion criteria across sites (964, 472, and 526 encounters at sites A, B, and C, respectively). Of the 1,962 total encounters, a general ED provider saw 560 (28%) patients across all sites combined. The proportion of patients seen by a general provider at each site was 15.6%, 17.6%, and 62.5% at sites A, B, and C, respectively. Despite 24-hour coverage by pediatrics-trained providers at site A, general providers who occasionally moonlight in the pediatric ED saw some patients.

During the baseline period, the mean CT rate for all providers was 18%. Following the intervention start, we experienced a special cause variation that prompted a shift in the centerline. The intervention period had a mean of 13%; this represents a 5% absolute reduction. One other instance of special cause variation occurred during the intervention period when we had 2 out of 3 points beyond 2 SDs from the mean (month 4 was >2 SDs below the mean and month 6 was >2 above it) (Fig. 2).

We performed a planned subanalysis by provider type, looking at pediatric ED providers (PEM physicians and acute care pediatricians) and general ED providers. During the baseline period, pediatric ED providers had a lower mean CT rate than general ED providers (15%

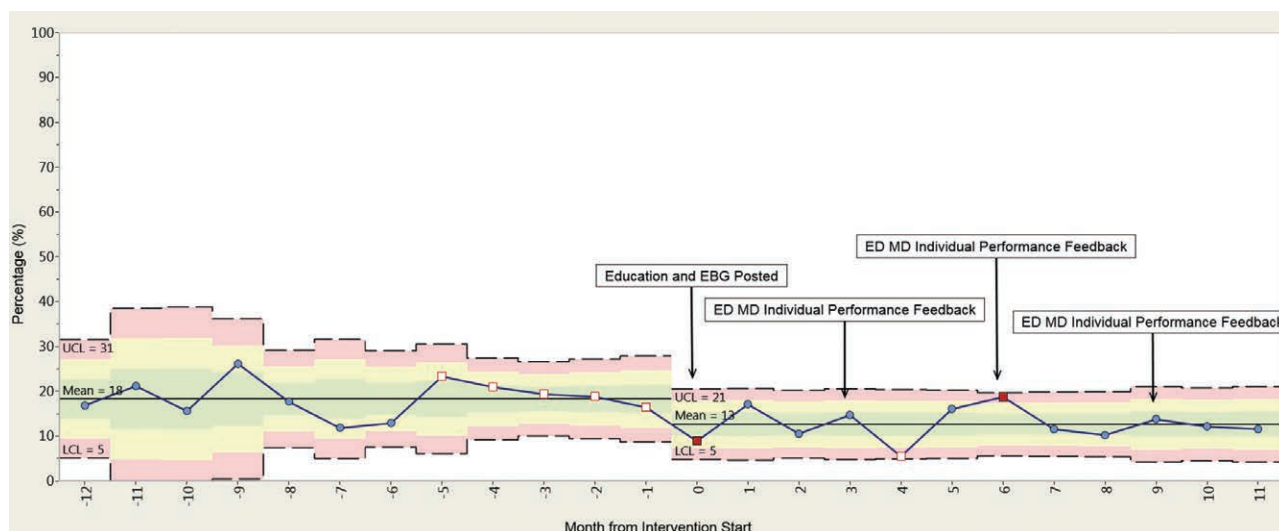


Fig. 2. The percentage of pediatric patients with MHT who had a cranial CT scan at 3 community hospitals. LCL, lower control limit; UCL, upper control limit; MD, physician.

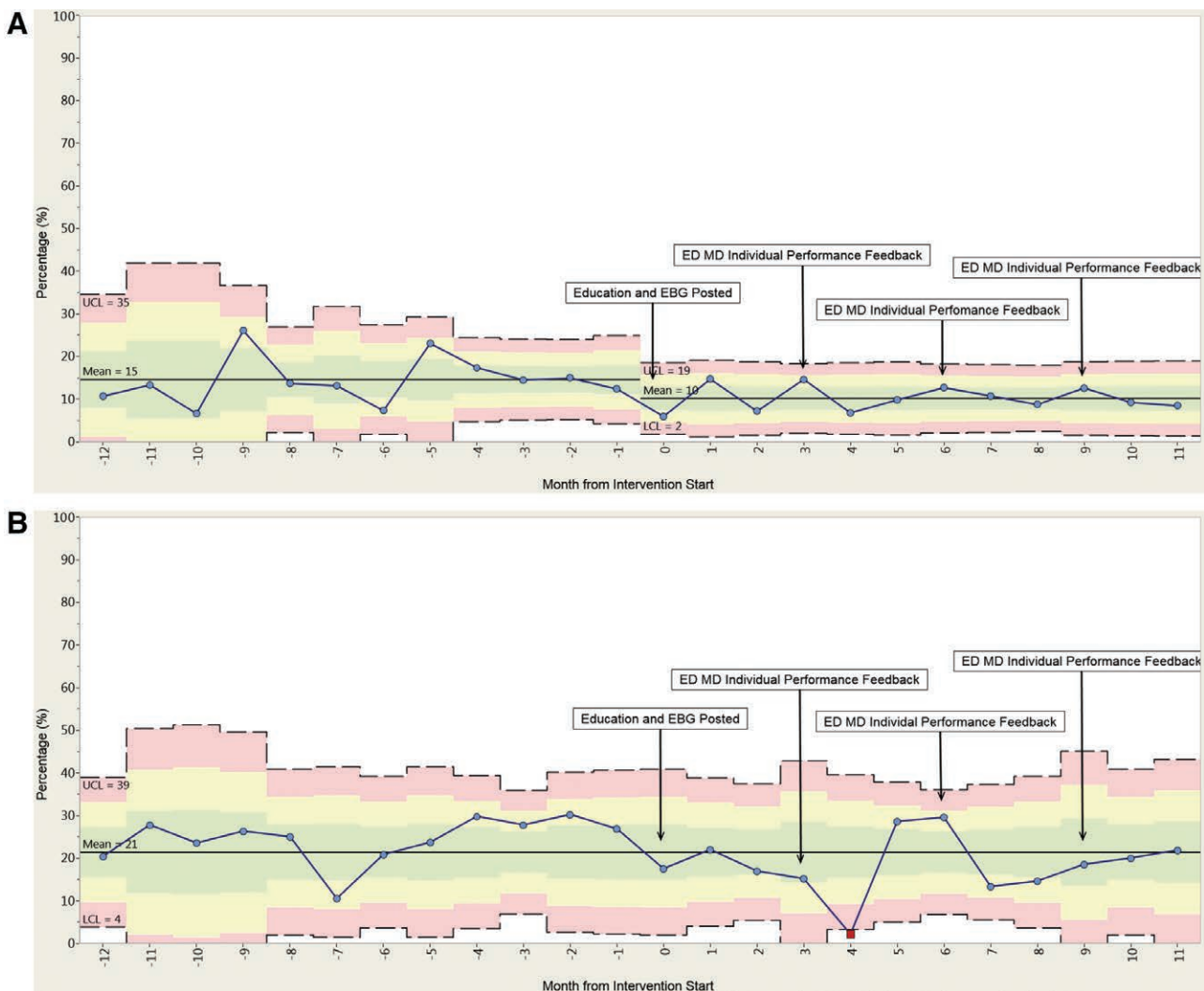


Fig. 3. P-charts by provider type. A, The percentage of pediatric patients with MHT seen by a pediatric ED provider who had a cranial CT scan at 3 community hospitals. B, The percentage of pediatric patients with MHT seen by a general ED provider who had a cranial CT scan at 3 community hospital. LCL, lower control limit; UCL, upper control limit; MD, physician.

versus 23%). In the p-chart for pediatric ED providers, we had special cause variation prompting a mean shift following the intervention start. For these pediatric ED providers, the mean CT rate during the intervention period was 10%, representing a 5% absolute decrease in the CT rate. The p-chart for general providers does not reveal a shift in the mean postintervention (Fig. 3).

Subanalysis by the site revealed a shift in the mean postintervention at sites B and C. At site B, from a baseline CT rate of 17%, there was an absolute drop of 5% during the intervention period. At site C, from a baseline CT rate of 19%, there was also a 5% drop during the intervention period. There was no shift in the mean in the intervention period at site A (Fig. 4).

There was no significant difference in the proportion of patients returning to the ED within 72 hours of discharge when comparing the baseline (5.4 per 1,000 visits) and intervention (5.6 per 1,000 visits) periods (rate difference, 95% CI = -0.2 per 1,000 visits (-4.5/1,000, 4.1/1,000).

Also, no patient in either the baseline or intervention period who returned within 72 hours met criteria for clinically significant traumatic brain injury.

DISCUSSION

We successfully used a multifaceted QI initiative to decrease cranial CTs for pediatric MHT at a community hospital ED network, without an increase in missed clinically important traumatic brain injury. We saw a significant drop in the mean CT ordering rate at 2 of the 3 sites in the study. Although both pediatric and general ED providers staff these community hospital EDs, it was pediatric providers who saw the majority of the patients and who drove this decrease in CT ordering rates. We did not see a statistically significant change in the ordering practices of general providers.

The lack of reduction in the general provider CT ordering rate may be a product of their comparatively

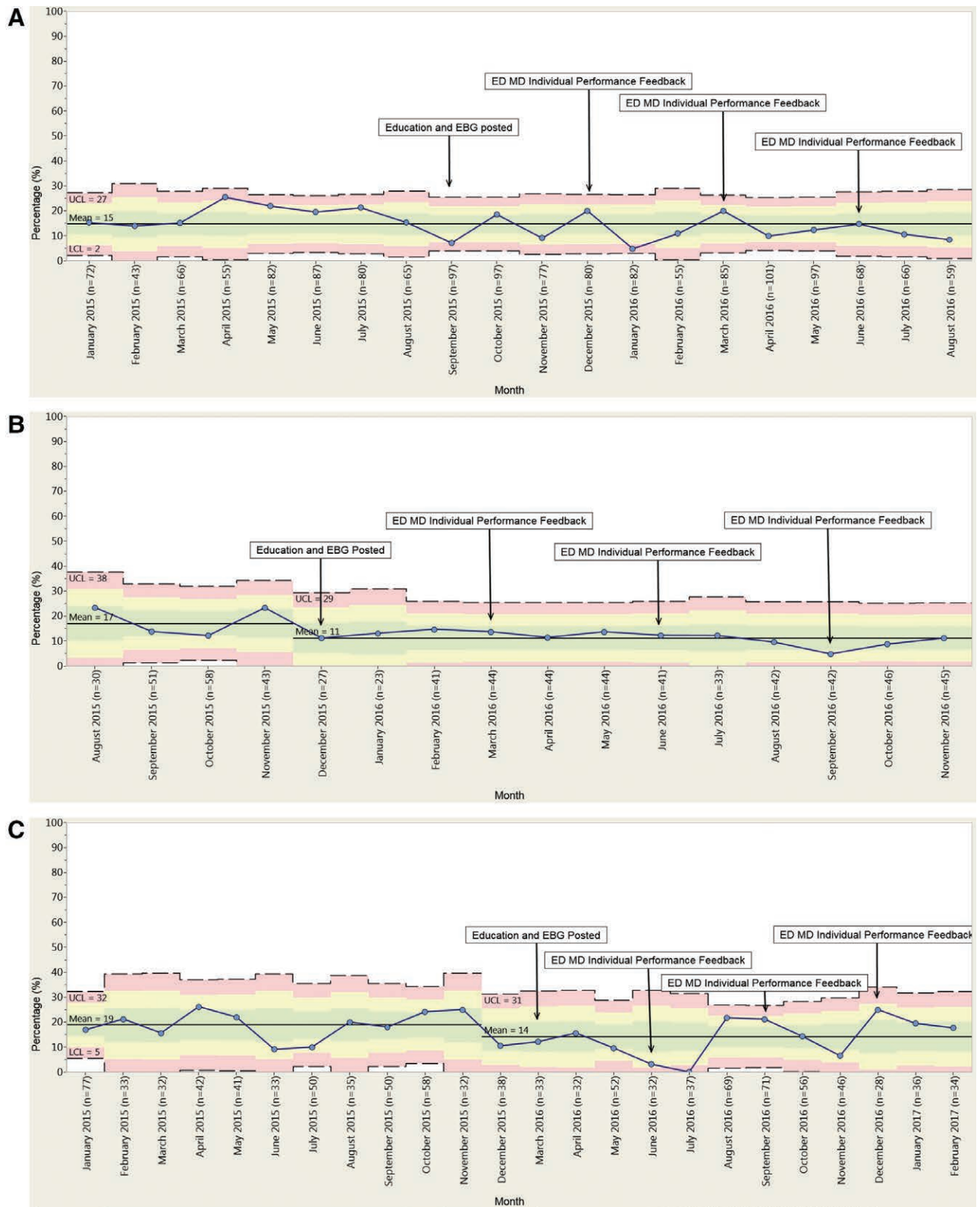


Fig. 4. P-charts by location. A, The percentage of pediatric patients with MHT who had a cranial CT scan in the ED of community hospital A. B, The percentage of pediatric patients with MHT who had a cranial CT scan in the ED of community hospital B. C, The percentage of pediatric patients with MHT who had a cranial CT scan in the ED of community hospital C. LCL, lower control limit; UCL, upper control limit; MD, physician.

smaller number of encounters (28% of the intervention encounter total) driving variability in month-to-month rates. However, the fact that pediatric practitioners drove the success of a pediatric intervention speaks to the important role that context plays in the success of QI interventions.¹⁹ Several key contextual factors are worth considering including the QI team and the organizations themselves.¹⁹ In this intervention, when creating our QI teams, we did not actively recruit general ED providers, and pediatric providers made up the majority of team members at each site. This decision might have impacted effective dissemination of practice. Regarding the organization, pediatric and general providers were integrated to different degrees at each site. We did not have the sample size to break down the p-charts by both site and provider, but it seems that there is a trend of greater impact on general provider behavior at those sites with higher integration between the 2 groups. These sorts of contextual factors may have also contributed to the absence of an intervention effect at site A. Site A also had the lowest baseline CT rate (15%), which also may have impacted our ability to see a significant shift in the mean at that location.

Interventions targeting pediatric care at community hospitals are necessary, as the majority of children seen in EDs are treated in these facilities.^{16,17} Also, the cranial CT rate in community hospitals is generally higher than that in freestanding children's hospitals.¹⁵ The significant reduction in the cranial CT rate seen here is important, given the risks of ionizing radiation and the expense associated with cranial CTs.^{4,7} The reduction in ionizing radiation is of particular interest in community hospitals, as small nonteaching hospitals are also less likely to use a dose reduction protocol for pediatric cranial CTs,²⁰ although these participating sites have dose reduction protocols in place.

Although community hospitals EDs are important sites for pediatric QI interventions, there are challenges associated with projects that target them. Pediatric patients usually represent a fraction of the patient volume at a community hospital, and there are fewer national metrics in community-based pediatrics. Therefore, local resources are often focused on adult-based performance. At one of our sites, there was an 8-month lag in obtaining automated data reports. One of the advantages of the staggered start model is that this prompted us to reach out earlier to the IT departments at subsequent sites. We have learned that the success of such an intervention hinges on early partnerships with local hospital leadership to ensure appropriate IT resources dedicated to data extraction and analysis.

When working with community hospital partners within a freestanding children's hospital network, additional considerations must be made to choose and structure improvement interventions in such a way that strengthens the relationship. We have had success in involving each site in project selection, creating teams of multidisciplinary stakeholders, and adapting interventions to local practices

and preferences. Based on our experience with this project, we recommend that general providers are part of that QI team. We have also found value in providing blinded network-wide data, to allow each hospital to understand its progress relative to nearby facilities. Finally, we have worked to include support for QI interventions in the affiliation contracts for these network hospitals.

Our results should be considered in light of methodological limitations. The involved sites do not universally report a Glasgow Coma Score. Instead, we used discharge from the ED as one of our inclusion criteria to exclude patients whose injuries would likely make them ineligible for the EBG. Although this may have resulted in missed patients, this logic was applied across all sites and throughout the baseline and intervention periods, and should not have contributed to the intervention effect we describe. Also, our data extraction capabilities did not allow for the collection of patient demographic data across all 3 sites. However, we suspect a similar demographic population in the baseline and intervention groups given the absence of any recruiting efforts or known large demographic shifts in the area during baseline and intervention periods. Difficulties with data extraction and automated report creation also resulted in different durations of baseline data collection at each site. Also, the trend in pediatric cranial CT rate for MHT in community hospitals nationally during this period is unknown, although the rate at the affiliated freestanding children's hospital remained stable. Although we tracked readmissions within 72 hours, we are unable to account for readmissions if patients presented to a different hospital. Finally, although both pediatric and general providers staff our sites, the results may not be generalizable to sites that are staffed exclusively by general providers.

CONCLUSIONS

This QI intervention successfully reduced cranial CT rates for pediatric MHT without an increase in missed clinically important traumatic brain injury at a network of 3 community hospitals associated with a freestanding children's hospital. As most emergency medical care is provided in community hospitals, expanding proven QI interventions to the community is essential to disseminate best practices.

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DISCLOSURE

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

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