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Pediatric Patient Surge: Evaluation of an Alternate Care Site Quality Improvement Initiative

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ABSTRACT

Background: Pediatric Level I trauma centers often experience patient volume surges. The increase stresses the emergency department, and usual patient care areas become inadequate. The purpose of this quality improvement study is to describe the implementation and analysis of an alternate care site to facilitate patient flow during seasonal patient volume surges.

Methods: This initiative used a nonequivalent historical control group posttest-only design. An alternate care site was selected because of its size, temporary nature, low cost, and proximity to the emergency department. The alternate care site was activated between January and March 2019 using the following criteria: the total number of patients in waiting room 30 or more and wait times 2.5 hr or more. Outcome metrics include total census, length of stay—admissions, length of stay—discharges, left without being seen, hours per patient visit, patient satisfaction scores, and process metrics. Descriptive statistics and *t* tests were used to determine differences between groups.

Results: A total of 180 patients were analyzed with $n = 90$ from 2018 and $n = 90$ from 2019. The alternate care site was activated five times over one season. The alternate care site decreased median waiting times, length of stay—admissions, length of stay—discharges, and left without being seen as compared with the previous year. Hours per patient visit and patient satisfaction scores remained constant as compared with the previous year.

Conclusions: The creation of an alternate care site within the emergency department allowed quick mobilization, response, and treatment of patients. The alternate care site decreased median length of stay for admissions, discharges, and who left without being seen while keeping hours per patient visit and patient satisfaction constant. Future studies should confirm findings by testing the alternate care site in other hospitals and settings and should consider formally evaluating staff satisfaction.

Key Words

Alternate care site, Outcomes, Patient surge, Pediatric emergency department

Health care systems are tasked daily with handling the rapid intake of patients through the emergency department (ED) (Jarvis, 2016). A variety of circumstances ranging from natural disasters, acts of terrorism, pandemics, to seasonal variations can cause the ED to face overcrowding and easily reach surge capacity (Chiu, Sheu, & Chi, 2012; Jarvis, 2016; Sarita et al., 2013).

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Overcrowding is defined as excessive patient volume that causes the ED to provide care in spaces outside the normal treatment areas and poses a risk to patient safety or quality of care (Erenler et al., 2016). Surge capacity, or the maximum number of patients who can be managed during an unexpected influx in volume, is exceeded when overcrowding causes the resources to be depleted (American College of Emergency Physicians, 2017). Surge capacity is particularly relevant to trauma centers that experience an influx of trauma patients during mass casualty or other no-notice incidents (Assistant Secretary for Preparedness and Response, 2019). Trauma centers must balance providing care to the lower-acuity patients while addressing the high-acuity trauma patients (Assistant Secretary for Preparedness and Response, 2019).

In a National Trauma Data Bank review of 347 Level I–II trauma centers, the average number of total beds was 460, yet trauma center overcrowding remains a concern (Faul, Sasser, Lairet, Mould- Millman, & Sugerman, 2015). In one study of 65 trauma centers, slightly less than half reported overcrowding and insufficient bed capacity (Velt et al., 2018). Overcrowding is linked to a decrease in quality of care, and an increase in medical errors, walkouts, total length of stay (LOS), and mortality (Salway et al., 2017). Overcrowding limits throughput, or patient flow, which can be costly to the organization and negatively impacts the patient experience (Zodda & Underwood, 2019). There is some evidence that crowding alone is not associated with poor trauma outcomes (Singh et al., 2019). Instead, the extended ED LOS that can result from decreased throughput during periods of overcrowding is a more reliable predictor of poor trauma care outcomes (Singh et al., 2019). An alternate care site (ACS) provides a solution to overcrowding for trauma centers.

Exceeding surge capacity can occur even in the absence of pandemics and disasters (Institute of Medicine, 2007). For example, high levels of respiratory illnesses such as bronchiolitis, respiratory syncytial virus, and influenza in the winter months frequently cause pediatric trauma center ED patient volumes to surge by 18%–95% over an average daily census (Bourgeois & Shannon, 2007), even at subpandemic levels. The American College of Emergency Physicians states that health care systems should plan to maximize throughput and create a plan to accommodate surges (American College of Emergency Physicians, 2017).

The ED response to the sudden influx of patients varies widely; common responses may include continuing normal day-to-day processes without adapting to the surge, use of hallway beds for patient care areas, or caring for patients within the waiting room (Freibott, 2017; Rixe et al., 2018). Emergency departments have used a variety of ACSs to improve throughput. Examples include use of tents set up in parking lots, establishing medical trailers, use of off-site clinics, facility lobbies, and other hospital units as adjunct overflow care sites (Chung, Monteiro, Hogencamp, Damian, & Stack, 2011; Kelen, Scheulen, & Hill, 2001; Shin et al., 2012). Yet each of these ACS options has its drawbacks. There is a need for low-cost, agile ACS options near the ED that can be rapidly set up and broken down.

The purpose of this study is to describe the implementation and analysis of an ACS within the ED to facilitate patient throughput during seasonal volume surges. The hypothesis is that an ACS will improve throughput outcomes—LOS—admissions, LOS—discharges, left without being seen (LWBS), and hours per patient visit (HPPV)—while maintaining patient satisfaction (measured as net loyalty score) for patients in a pediatric Level I trauma center ED.

METHODS

This quality improvement (QI) initiative used a nonequivalent historical control group posttest-only design and is reported using the Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0) guidelines (Ogrinc et al., 2016). The study took place from October 2018 to April 2019 at a large, academic pediatric Level I trauma center in Austin, TX, which serves as the only pediatric Level I trauma center in the region, serving more than 46 counties in central Texas. The hospital serves approximately 70,000 patients a year. It comprises 44 patient rooms, four triage rooms, and three waiting rooms and covers 30,400 ft^2. The hospital system uses the Cerner electronic medical record.

Protocol Development, Implementation, and Evaluation

An interdisciplinary hospital leadership team developed the protocol document as a solution for when the ED reaches surge capacity. Initial barriers or concerns in the development of this document include the physical location of the ACS, activation and deactivation criteria, patient privacy, the fire code, and city codes, and cost (Table 1). Stakeholders followed the Plan-Do-Check-Act process (Agency for Healthcare Research and Quality [AHRQ], 2015) and finalized the protocol in December 2018. After implementation, it was modified again in January 2019. The modification added a process to notify hospital leadership of ACS activation and increased communication for affected hospital units and other stakeholders. The primary measure of effectiveness was ED throughput metric improvement (i.e., a decrease in LOS—admissions, LOS—discharges, LWBS, and HPPV) without compromising patient satisfaction. To ensure that the changes could be attributed to the intervention, no other operational changes were made. The QI project did not require a formal ethics review via an Institutional Review Board. No conflicts of interest were identified in the conduct of this study.

Activation Criteria

The activation criteria and ACS setup are described in Table 1. Prior to activation of the ACS, the team devised two ways to combat the increased patient volume: (1) utilize hallway beds and (2) convert two triage rooms into patient examination rooms. When both methods failed to improve ED throughput, the next step was to consider the implementation of the ACS.

Measures

Measures are defined in Table 2. All outcome data except patient satisfaction scores were extracted from the Tableau data visualization software. Patient satisfaction scores (defined as net loyalty scores) were obtained from the third-party independent evaluation group's website.

Data Analysis

The metrics are reported daily as part of standard operations and thus were initially reviewed immediately following each ACS activation. Additionally, data were analyzed for this QI project after the full season was complete. Data were analyzed using descriptive statistics and

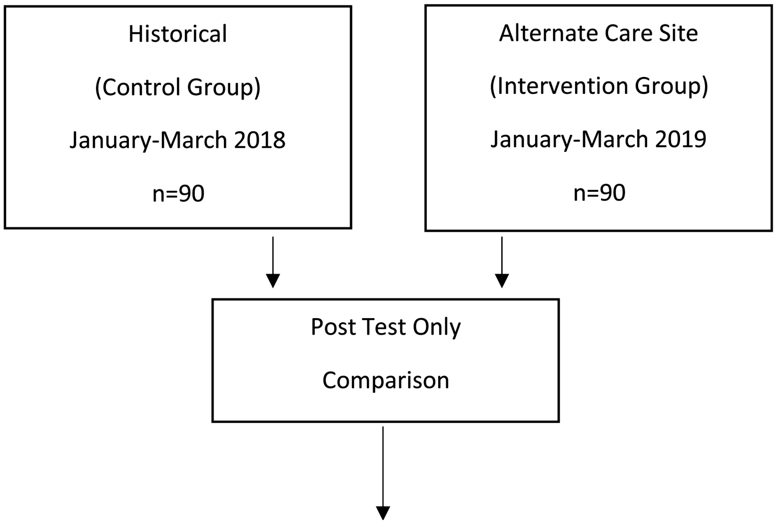
TABLE 1 Protocol Development and Overview

Initial Barriers and Considerations	
Physical location	*Desired features*: • Proximity to ED • Available on short notice • Spacious (approximately 700 ft^2, two bathrooms, water fountain, and controlled entrance/exit) • Private *Solution*: Waiting room within the ED *Alternatives considered*: Closed unit on another level of the hospital, a small break room contained within the ED, the hospital's auditorium
Activation criteria	1. ≥30 patients in the waiting room 2. Patients waiting ≥2.5 hr for an ED room 3. Adequate staffing: • Two dedicated RNs • One dedicated PCT • More than 1 physician/advanced practice provider
Deactivation criteria	1. ≤15 patients in waiting room 2. Patients waiting ≤1.5 hr for an ED room
Patient privacy	*Solution*: Partitions *Advantages*: Mobile, easy to set up and break down, lightweight, and low cost
Fire and city codes	Approval was granted without any additional modifications to meet the appropriate fire and city codes.
Cost	*Desired features*: • Solution that did not require additional capital or operating costs • Physical location should not require any construction or additional cost to use the space • Activation/deactivation criteria were designed so as not to require additional resources to implement the protocol • Patient privacy concerns met with the lowest cost possible • Fire and city codes met without requiring additional expenses
Alternate Care Site Setup	
Initiation and setup	*Initiation*: Charge nurse notifies leadership that criteria are met *Setup ACS (time required: 20 min)*: Four to five staff members convert waiting room to nine patient examination rooms using partitions; care team stationed near patients *Equipment needed*: • Two thermometers • Two computers on wheels • Two mobile vital sign machines • Cart with basic examination supplies (i.e., thermometers, masks, and point-of-care testing supplies)

Note. ED = emergency department; PCT = patient care technician; RN = registered nurse.

compared with the previous year (January through March of 2018). Also, after assumptions were checked, a *t* test for independent samples was used to determine differences between groups. A second analysis using descriptive statistics was conducted for direct comparison with ACS activation days ($n = 5$) between January and March 2019 in which only dates with an ED census more than 260 patients from the previous year ($n = 26$) were used.

TABLE 2 Project Design Flowchart



Outcome Measures		
#	Metric	Definition
1	Total census	Total number of patients checked in from 12:00 a.m. to 23:59 p.m.
2	Length of stay—admissions	Total time that patients who were admitted to the hospital spent in the ED from the time of check-in to the time they left the department
3	Length of stay—discharges	Total time that patients who were discharged home spent in the department from the time of check-in to the time they left the department
4	Left without being seen	Patients who left the department without being seen by a health care provider (nurse practitioner, physician assistant, or physician)
5	Hours per patient visit	Total number of labor hours of ED staff (nurses, patient care technicians, sitters, and support staff) providing patient care at the bedside divided by the total patient visits per 24-hr period
6	Patient satisfaction	Net loyalty score drawn from the Professional Research Consultants, Inc (2020), a third-party group which evaluates patient satisfaction after discharge via telephone survey
7	Process measures	Adherence was assessed via an email from the charge nurse after the shift with ACS activation was complete
8	Cost	Defined as materials and equipment, permitting fees, or other expenses to set up ACS

Note. *ACS = alternate care site; ED = emergency department.*

RESULTS

The ACS was activated five times between January 2019 and March 2019.

Patient Characteristics

Patients who received care in the ACS area were classified as Emergency Service Index (ESI) acuity Levels 4 and 5, which means they were the lowest acuity patients (AHRQ, 2014). Level 4 means the patient requires one resource (i.e., one type of intervention, such as laboratories, tests, diagnostic imaging, intravenous fluids, specialty consult, etc.), and Level 5 means the patient requires zero resources (i.e., simple wound care, point of care testing, oral medications, etc.).

Throughput Analysis

Table 3 displays the results of the overall variables for the periods between January 1 and March 31 of each year (N = 180, n = 90 from 2018 and n = 90 from 2019). Variables met assumptions of normality for the t test. Total volume was slightly higher for the 90-day period in 2018 (M =234 patients per day) than it was in 2019 (M = 217 patients per day), a difference of 7.8% or 17 patients on average per day ($t(178) = 2.877$, $p = .005$). LOS—admissions ($t(178) = 2.341$, $p = .021$) and LWBS ($t(178) = 3.318$, $p = .001$) were significantly lower in 2019 than in 2018. LOS—discharges were also lower, although the difference was not statistically significant ($t(178) = 1.826$, $p = .069$). HPPV was not statistically

TABLE 3 Mean Throughput Metrics of Historical Control and Alternate Care Site Groups

Variable	Historical Control Group January to March 2018	Alternate Care Site Group January to March 2019	t-Statistic	Significance*
	M (*SD*)	*M* (*SD*)		
Total volume (patients)	234 (45.52)	217 (29.07)	2.877	.005
Length of stay—admissions (min)	254 (41.59)	241 (30.19)	2.341	.021
Length of stay—discharges (min)	167 (28.28)	160 (23.76)	1.826	.069
Left without being seen (%)	1.10 (1.21)	0.58 (0.79)	3.318	.001
Hours per patient visit	2.26 (0.36)	2.70 (2.47)	−0.172	.864

**Significance of 2-tailed t test (df = 178), p value.*

different from 2018 to 2019 ($t(178) = -0.172$, $p = .864$). Patient satisfaction remained unchanged; the net loyalty score was 79.4 percentile in 2018 and 80.1 percentile in 2019.

Table 4 displays the results for January 2019 to March 2019 when the ACS was activated ($n = 5$ days) as compared with the same months from the previous year when the ED volume exceeded 260 patients ($n = 26$ days). In 2019, the median LOS for patients discharged home decreased by 22 min (−11%). The LOS for patients admitted was 11 min less (−3.9%). The most substantial change was the decrease in LWBS. In 2019, it was 0.8% versus 1.65% in 2018 (−51%). During both periods, the HPPV remained constant (0% change).

Process Measures

No deviations from the protocol or unanticipated problems were identified during each of the ACS activations. No data were missing from the dataset. The cost of the implementation amounted to less than $1,000, primarily due to purchasing the privacy partitions.

DISCUSSION

The goal of the ACS was to provide an efficient means of evaluating, treating, and discharging patients quickly, thus improving ED throughput, while also maintaining or improving patient satisfaction. Based on the results of this QI study, this ACS protocol was an effective solution. This approach was a low-cost method that was easy to implement, was close to the normal ED patient care spaces, and maintained both patient privacy needs and operational building safety requirements without adding additional resources.

Total Volume

The total patient volume between January and March 2018 was 7.8% higher, or 17 patients more per day than the same period in 2019. In a comparison of the overall period, the groups are slightly different at baseline. However, in our subsequent comparison evaluating only days of patient volume more than 260 (Table 4), the throughput metrics still demonstrated an improvement in 2019 over comparable days in 2018. It is reasonable to conclude that the difference is not only a result of a decrease in patient volume but rather a result of the ACS activation during a surge in patient volume.

Length of Stay—Admissions

LOS—admissions were significantly lower in 2019 than in 2018 ($p < .05$), which meant that, on average, admitted

TABLE 4 Median Day Comparisons of Historical Control and Alternate Care Site Groups

Metric	Historical Control Group January to March 2018	Alternate Care Site Group January to March 2019	Percent Change
Patient volume (average)	290 patients	282 patients	−2.8%
Length of stay—discharges (median)	199 min	177 min	−11%
Length of stay—admissions (median)	282 min	271 min	−3.9%
Left without being seen (median)	1.65%	0.8%	−51%*
Hours per patient visit (median)	1.9	1.9	0

**p = .001.*

patients were sent to their respective units 11 min faster. Previous literature has focused on improving the back-end of hospital throughput to improve ED throughput, such as focusing on improved efficiency via discharging inpatients from the units more quickly to open up more beds for ED patients to be transferred into (Mumma, McCue, Li, & Holmes, 2014). Mumma et al. (2014) concluded that ED expansion alone does not appear to improve throughput in cases of overcrowding and may even increase LOS—admissions. It is notable that the findings from our study contradict previous literature and suggest that adding additional rooms temporarily in the ED based on a surge can also benefit overall efficiency and throughput without a change to the back-end processes.

Length of Stay—Discharges

Patients were sent home an average of 22 min sooner in 2019 as compared with comparable days in 2018. Because most of the patients seen in the ACS were ESI acuity Levels 4 and 5, the benefit to discharges may be attributed to the increased efficiency of having all Level 4 and 5 patients grouped together and having additional rooms to see these patients. By getting these patients home more quickly, it allows the ED staff to focus on their higher-acuity patients.

Left Without Being Seen

LWBS decreased more than any other throughput metrics. By addressing the lowest acuity patients more quickly through the additional care areas created by the ACS, fewer patients left the ED without being seen. Hsia et al.'s (2011) study concluded that hospitals with a high proportion of low-income or uninsured patients are more likely to have high LWBS rates. Patients arriving to the ED with nonemergent issues may not have a primary care physician, or they have difficulty getting an appointment, which puts pediatric patients at risk not to receive care. Although this study did not directly measure the characteristics of the patients receiving care in the ACS, future studies should explore whether the ACS ensures access to care for these patients in a reasonable period of time.

Hours Per Patient Visit

All data measured decreased except for HPPV, which remained unchanged. The ACS improved ED flow while maintaining the same personnel levels as the previous year during the same time frame. However, due to the way HPPV is tracked and calculated, it is impracticable to determine whether the mix of clinicians (i.e., number of registered nurses vs. the number of patient care technicians on-shift at any given time) was different from year to year. It is unknown how the mix of clinicians may impact the metrics.

Patient Satisfaction

Patient satisfaction, measured by the net loyalty score after discharge, remained the same despite the implementation of the ACS. Because the net loyalty score is reported monthly, it is impracticable to attribute the net loyalty score solely to the implementation of the ACS protocol. However, it is favorable that the scores were comparable during the same period despite the changes, and scores did not decrease as a result of new processes.

Cost

The overall cost of ACS implementation was minimal. The estimated cost of setting up medical tents in the parking lot can be as high as $130,000 depending on the geographic region. In comparison, the ACS described in this study was only a fraction of that price; the primary cost was the purchase of seven portable privacy partitions. The total of less than $1,000 for the ACS in the current study was inexpensive when compared with expenses like renting medical tents, trailers, or extra space outside the hospital.

Limitations

The primary study limitation was in the tracking system for the ACS. The number of patients seen in the ACS was tracked on paper by the provider and the registered nurse(s) providing care in the location. The staff did this by placing patient registration labels on a sheet of paper that was posted in the area. When the care site was closed, the paper was then given to the charge nurse, who then sent the information to the ED leadership. Due to paper tracking, we are unable to characterize further the patients who were seen in the ACS beyond their ESI acuity level (i.e., age, gender, ethnicity and race, and type of insurance). This method worked for the department because it was simple and easy to implement even though it was not integrated with the electronic ED management system. Future studies may consider an electronic tracking system for increased integration with existing systems. Additional limitations of the nonequivalent historical control posttest-only design include that it does not account for secular trends, and potential selection bias, which may threaten the validity and can overestimate the magnitude of benefits. Another potential confounder is that the unit clinician mix varied from year to year, although it is unknown how that difference may have affected the results. Despite this challenge, even with the potential variability in staffing, the HPPV remained the same, which indicates that the ACS, as described, can be implemented without increasing labor needs.

Recommendations

Our findings indicate that an ACS is useful for improving ED throughput during a patient surge. It is beneficial to utilize space within the ED in creative ways to establish an ACS. Future studies should implement the ACS at other locations to confirm findings, while also incorporating creative solutions for tracking patient characteristics in the ACS.

Future studies may also consider evaluating the effects of the ACS on staff well-being because ED overcrowding can lead to negative effects on staff. Potential negative effects on staff include increased stress, increased exposure to violence, and decreased adherence to clinical practice guidelines (Morley, Unwin, Peterson, Stankovich, & Kinsman, 2018). Future studies should explore whether an ACS can counteract such negative effects of overcrowding on ED staff.

Alternative Applications

The ACS described in this QI project lends itself to additional applications. For example, the ACS could be used for mass casualty incidents that require the facility to respond urgently. The ED ACS can be activated to provide care for trauma victims, particularly for the walking wounded. These are stable patients with minor illnesses or injuries that do not require life-saving interventions. This ACS space allows for additional patients to receive care without hindering the flow in the trauma areas. Specifically, triaged patients can be separated into designated care areas. By streamlining and separating patients to designated areas, it maximizes efficiency and conserves vital resources.

CONCLUSION

This QI study demonstrates that hospital systems can respond to surges effectively and efficiently, without financial burden, by using an ACS that is mobile, easy to activate, and is close to the ED. Ultimately, our results indicate an improvement in ED throughput. Faster throughput is beneficial because it gets patients to their hospital room faster or home more quickly. If the service is more efficient, fewer patients are likely to leave without being seen due to delays.

KEY POINTS

- A pediatric Level I trauma center ED can respond to a patient surge effectively and efficiently by creating an ACS.
- The low-cost, mobile ACS improved ED throughput metrics as compared with the previous year while maintaining patient satisfaction scores and equivalent hours per patient visit.
- Future studies should evaluate the benefit of the ACS in alternate settings and other applications with creative solutions for tracking patients and process measures.

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