Individual QI projects from single institutions

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Reduction of Very Rapid Emergency Transfers to the Pediatric Intensive Care Unit

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ABSTRACT

Introduction: Emergency transfers are associated with increased inpatient pediatric mortality. Therefore, interventions to improve system-level situational awareness were utilized to decrease a subset of emergency transfers that occurred within four hours of admission to an inpatient medical-surgical unit called very rapid emergency transfers (VRET). Specifically, we aimed to increase the days between VRET from non-ICU inpatient units from every 10 days to every 25 days over 1 year. **Methods:** Using the Model for Improvement, we developed an interdisciplinary team to reduce VRET. The key drivers targeted were the admission process from the emergency department and ambulatory clinics, sepsis recognition and communication, and expansion of our situational awareness framework. Days between VRET defined the primary outcome metric for this improvement project. **Results:** After six months of interventions, our baseline improved from a VRET every 10 days to every 79 days, followed by another shift to 177 days, which we sustained for 3 years peaking at 468 days between events. **Conclusion:** Interventions targeting multiple admission sources to improve early recognition and communication of potential clinical deterioration effectively reduced and nearly eliminated VRET at our organization. *(Pediatr Qual Saf 2023;8:e645; doi: 10.1097/pq9.0000000000000645; Published online May 22, 2023.)*

INTRODUCTION

Pediatric respiratory and cardiac arrests outside the intensive care unit (ICU), commonly called code blue events, are associated with high in-hospital mortality.[1] Implementing rapid response systems reduces code events outside the ICU.[1–3] The successful efforts[1] to reduce code blue events allowed for shifted focus to more proximal outcome measures: reducing critical deterioration events or emergency transfer (ET) events.[4–6] These precursor events are more common than code blue events and associated with significant morbidity and mortality.[4,5] For example, ET mortality in our organization was associated with 10% mortality over an 8-year review period.

System-level efforts to improve situational awareness (SA) have been tested and implemented to decrease unrecognized inpatient deterioration, including code blues and ET.[5,7–9] SA allows individuals and teams to better predict and recognize early clinical deterioration signs[5,7,10] An example of an SA framework, known as a "Watcher Program," focused on identifying, mitigating, and escalating concerns.[5] Implementing this framework to improve SA successfully decreased ET events in several pediatric hospitals.[5,7–9]

Our institutional SA quality improvement (QI) project to reduce ET promoted early recognition of patients at risk for clinical deterioration in inpatient, non-ICU settings. This Watcher Program successfully decreased ET. However, 2 years into the improvement work, a new safety concern surfaced: ET that occurred quickly after admission, which we labeled very rapid emergency transfers (VRET). A study of ICU transfer within 4 hours of admission noted patients who met ET definition had significantly increased mortality.[11] Although anecdotal, our bedside teams identified VRET events as a priority despite the rarity of occurrence, as it strained system resources and stressed the teams providing direct patient

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care. In addition to the mortality risk, VRET can increase the risk of errors with each care transition.[12] VRET continued despite prior interventions aimed at early recognition and mitigation and required improvement work to extend beyond the inpatient setting.

The QI global aim was to increase SA of clinical deterioration to decrease ETs and code blue events outside the ICU. The specific aim was to increase the days between VRETs from every ten to every 25 days by March 31, 2018, with sustained improvement for 6 months.

METHODS

Context

The setting was an academic, quaternary-care, free-standing children's hospital. The hospital has 549 licensed beds, including 74 ICU beds with geographically distinct pediatric and cardiac intensive care units. Between 2017 and 2021, the hospital averaged 85,879 emergency department (ED) visits, 17,464 inpatient discharges, and 156,638 inpatient days (**See appendix 1, Supplemental Digital Content 1,** which shows emergency department and inpatient volumes. **http://links.lww.com/PQ9/A478**).

The following criteria define ET: an unplanned transfer from an inpatient unit to an ICU, with at least one of the following interventions within 60 minutes before or after the transfer: (1) Intubation, (2) 3 liters or >60 milliliters per kilogram fluid boluses, (3) vasoactive medication (specifically epinephrine, norepinephrine or dopamine), or (4) cardiopulmonary resuscitation. In addition, VRETs were defined as transfers meeting ET criteria within 4 hours of admission to the inpatient unit.

A daily report of transfers from the electronic health record (EHR; Epic Systems, Verona, Wis.) identified ET. A review of each transfer determined if the ET criteria were met. Data elements (service, unit, and contributing condition) were analyzed to identify trends. A multidisciplinary team reviewed ET and VRET with a standardized process to identify opportunities to improve and share learnings.

This article followed the Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0) Guidelines.[13]

Interventions

An interdisciplinary QI team was assembled and charged with decreasing VRET. The QI team included a nurse-physician dyad from an established Steering Committee for SA (Watcher Program), nurse and physician leaders from the ED, ICUs, ambulatory clinic, and inpatient general-medicine units. Additional team members included representation from patient placement, the sepsis improvement team, and executive sponsors. Meetings began in April 2017, and in August 2018, VRET improvement work was integrated into the SA steering committee.

Using baseline data, we developed Pareto charts of admission sources and contributing conditions to VRET to guide the development of a key driver diagram (Fig. 1). Then, utilizing the Model for Improvement plan-do-study-act cycles tested the interventions.[14]

A cohort of VRET with an ED admission source was identified with opportunities regarding initial disposition (ie, floor versus ICU), particularly in patients with sepsis and respiratory illness. In addition to ED provider discretion, Pediatric Early Warning Score (PEWS) contributed to the admitting unit decision. Though not validated in the ED,[15] PEWS has been extensively studied in inpatient units. Our ED calculates PEWS before admission to facilitate communication and assessment during care transitions. A mandatory self-paced learning module provided a PEWS educational refresher to ED nursing. In addition, a pilot was initiated of nurses from a general-medicine inpatient unit who assessed their admissions while the patients were still in the ED. Nursing and PEWS assessment by a floor nurse in the ED promoted proactive communication and care planning before transferring the patient. In addition, inpatient nurses could escalate concerns to inpatient and ED providers regarding patient acuity and appropriateness for floor admission.

VRET interventions also collaborated and aligned with simultaneous institutional sepsis work. This work included implementing an EHR (Epic Systems, Verona, Wis.) sepsis screening and alert in the ED and inpatient units. The screening model included documented assessment and laboratory data; if the automated screen was positive, the ERH displayed an interruptive system alert and decision support to clinicians.[16,17] Though the sepsis improvement team specifically designed, tested, and implemented sepsis-specific interventions,[16,17] work aligned with VRET improvement efforts as sepsis was the major contributing condition to VRET during the baseline period.

Another cohort of VRET cases involved patients who were direct admissions from hospital specialty clinics. The goal was to maintain direct admissions and not route all patients through the ED yet ensure safe triage and disposition to the floor. A working group developed an algorithm and handover communication methods to guide recommended vital sign assessments before a direct admission to ensure floor resources matched the patient's acuity (**See appendix 2, Supplemental Digital content 1,** which shows direct admission from clinic to inpatient algorithm. **http://links.lww.com/PQ9/A479**).

The final intervention focused on the institution's Watcher Program. The EHR sent an automated pager alert to the Safety Officer of the Day (SOD) for newly identified watchers to promote system-level SA.[5] The SOD is a hospitalist available 24/7 and responsible for conducting a chart review, communicating with the primary team, and if necessary, assessing patients identified as a watcher (ie, at risk for clinical deterioration). The alerts provided timely SA specifically for patients newly admitted who may not yet be recognized as a deterioration risk or have an existing mitigation or escalation plan. The ED staff may also consult the SOD to assist in appropriate

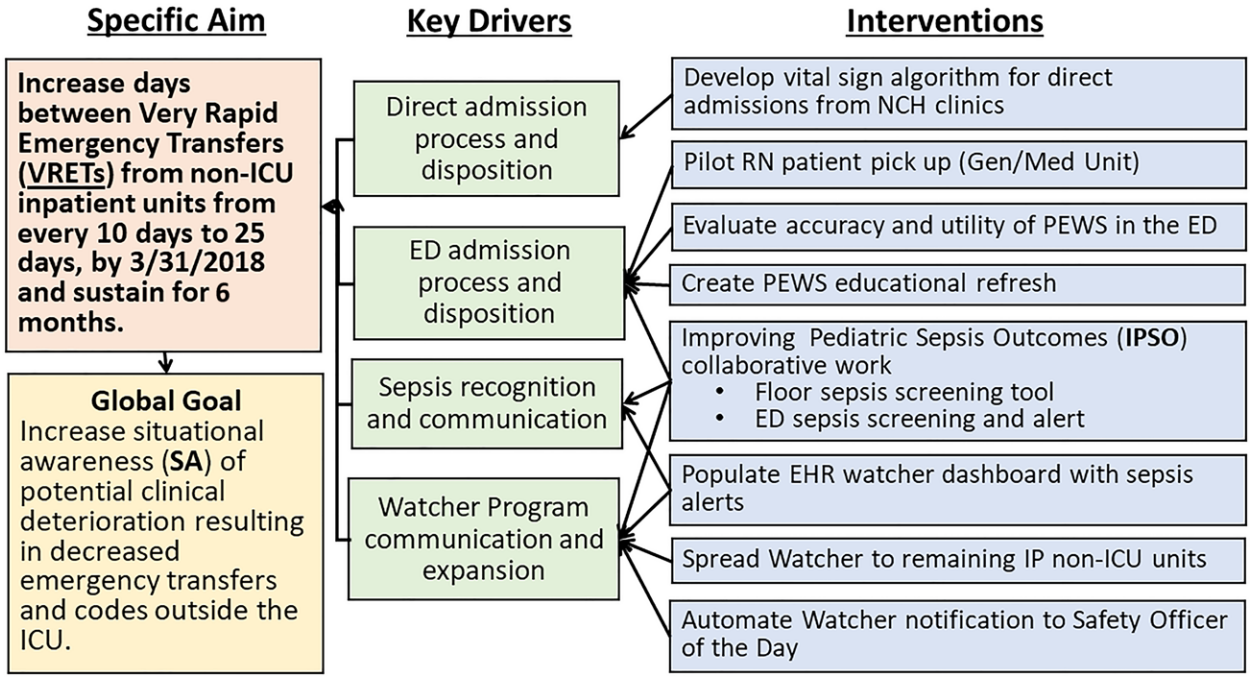


Fig. 1. Key Driver diagram: increasing situational awareness: VRET reduction.

admission patient placement. In addition, the SOD, who rotates every 7 days, staffs admissions, responds to rapid response calls, and addresses outside referrals.

Study of the Interventions

Statistical process control charts and Pareto charts were utilized to study the effects of the interventions. The standardized multidisciplinary event review process identified additional context and learnings. Although causation cannot be determined for the specific interventions, the timing of interventions correlated with special cause variation.

Measures/Analysis

"Days between VRET" defined the primary outcome metric. As VRET was a discrete but rare event, a statistical process control g-chart was created (Fig. 2). Data from October 2016 through March 2017 defined the baseline. The intervention began in April 2017 with the formation of the QI team. Standard rules for identifying special cause variation and centerline shifts were applied; in this case, a centerline shift for a point above the upper control limit or 3-sigma from the established centerline.[18] During the baseline and intervention periods, the team collected descriptive data, including VRET contributing condition and admission source, and Pareto charts compared frequencies (Figs. 3, 4).

The percentage of Assessment and Consultation Team (ACT) events for patients on the floor in less than 4 hours defined the secondary outcome metric. The ACT team is our version of a Rapid Response Team, consisting of a PICU fellow/attending, a Hospitalist attending, a PICU charge nurse, and a respiratory therapist. All patients potentially needing transfer from an inpatient unit to the ICU require an ACT. This metric was a leading indicator for potential VRET. A p-chart was utilized, given discrete, attributable data represented as a percentage of all ACTs (Fig. 5). October 2016 through March 2017 again defined the baseline and standard rules for centerline shifts applied.[18]

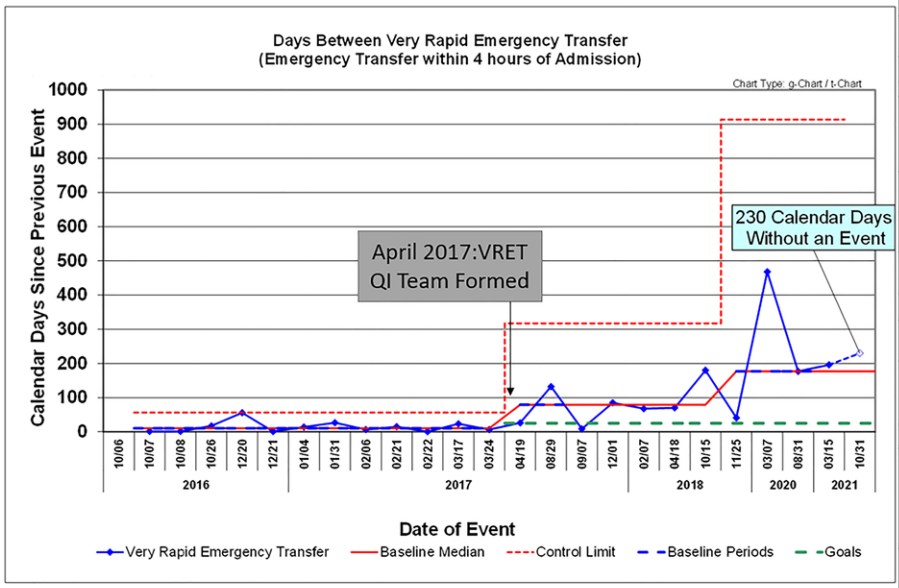
A process metric tracked floor registered nurse (RN) assessments of ED patients before their admission to the floor. To evaluate if their assessments were incongruent with the acuity and resources of the targeted general-medicine unit, we asked floor RNs to document answers to the following questions:

- Did your PEWS assessment match the most recent ED PEWS?
- Did you escalate any concerns? If yes, did the patient still transfer to the floor?

A convenience sample of this process metric was obtained for the 12-hour shift this RN was staffed.

Given that the interventions could negatively impact ED length of stay, our balancing measure was the percentage of patients transferred within 15 minutes of the ED RN documenting care was complete, a signal for transfer to the inpatient unit. Conversely, a decrease in the percentage of this metric could indicate prolonged time spent in the ED. The improvement team followed this metric for 12 months.

The other balancing metric was the percentage of ICU transfers after an ACT. We monitored activations and ICU transfers to ensure VRET interventions did not overburden the organizations' critical care resources. A



Intervention	Start Date
Formation of VRET improvement team	April 2017
ED patient assessment by Gen Med RN	May 2017
Direct admission algorithm change and dissemination	May 2017
Updated ED RN PEWS education	June 2017
EMR sepsis screening and alert in the ED	July 2017
Automation of Watcher notification to Safety Officer of Day	August 2017
BMT direct admit process change	January 2018
General Medicine/Infectious Disease inpatient EMR sepsis screening	March 2018
Spread of watcher program to remainder of inpatient medical/surgical units	August 2018
Inpatient EMR sepsis screening on majority of inpatient medical/surgical units	September 2018

Fig. 2. Statistical Process Control Chart: primary metric showing days between VRETs with the timeline of interventions.

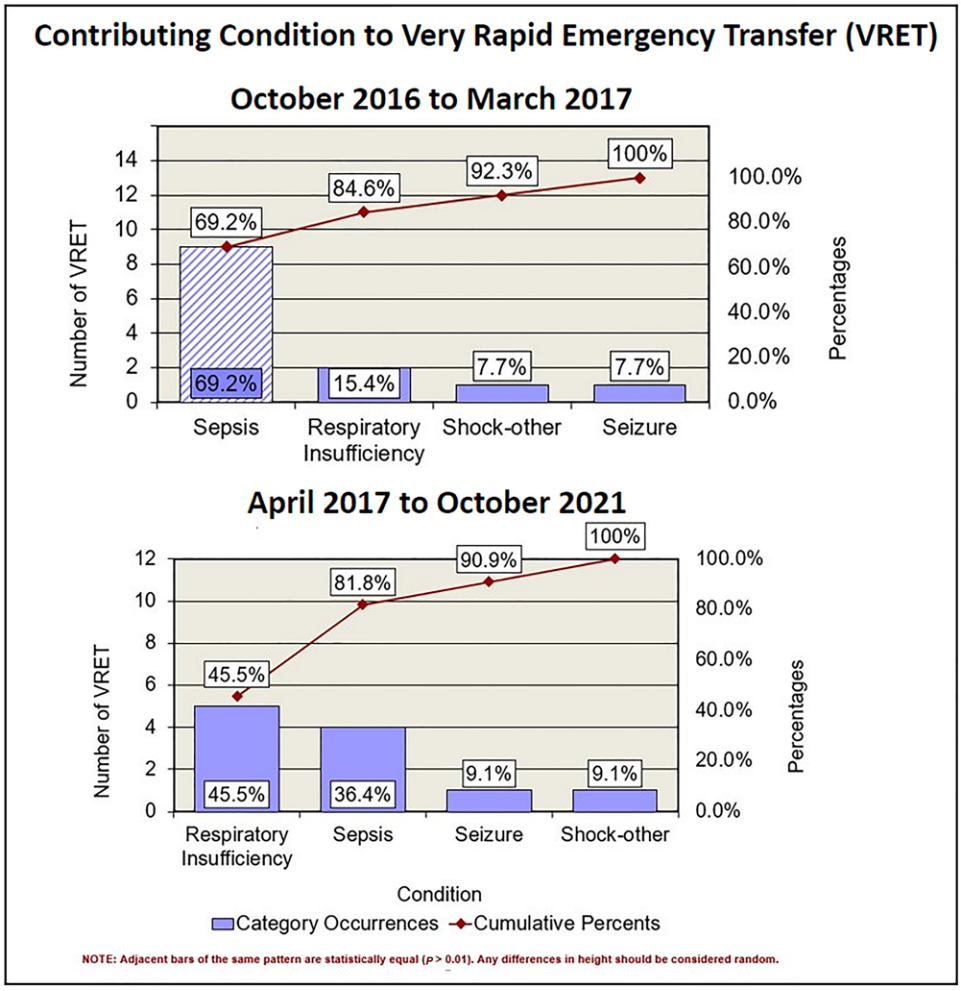


Fig. 3. Pareto charts showing contributing conditions to VRET.

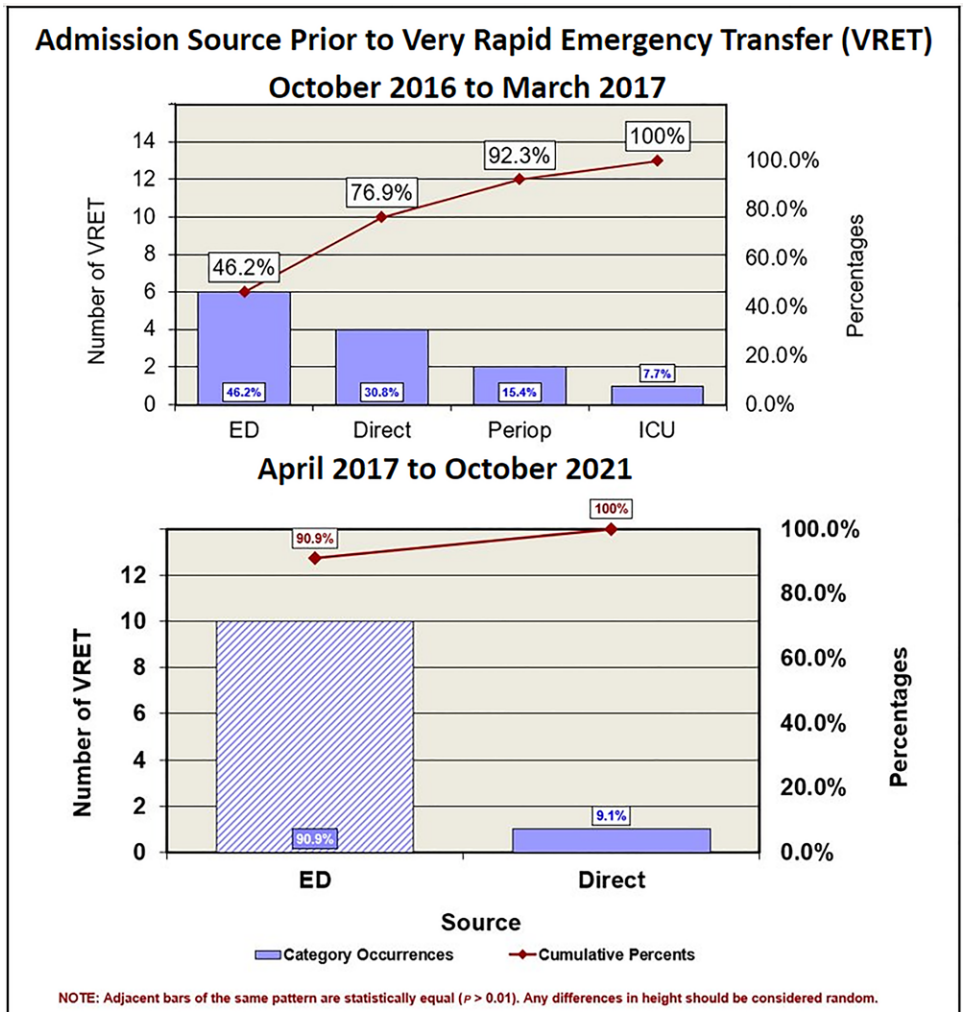


Fig. 4. Pareto charts showing admission source before VRET.

p chart monitored ICU disposition following an ACT (Fig. 6). Data from October 2016 through March 2017 established the baseline and standard rules for centerline shifts applied.[18]

Ethical Considerations

Per institutional policy, this project met the definition of QI, not human subject research; therefore, institutional review board approval was not required.

RESULTS

During the baseline period, VRET occurred on average every 10 days. Following QI interventions, 2 centerline shifts were observed (Fig. 2). The initial shift occurred after 132 days without a VRET between April 2017 and August 2017, resulting in a new centerline of 79 days between VRET. The second shift, occurred in November 2018, following a peak of 468 days between events leading to a new and sustained centerline of 177 days between events. A total of 13 VRET with 1 mortality occurred during the 6-month baseline, 11 VRET and 2 mortalities occurred during the 3.5-year intervention period for an overall VRET mortality of 12%.

Pareto analysis of events demonstrated contributing conditions similar to those of VRET during baseline and intervention periods (Fig. 3). Sepsis accounted for 69% of baseline VRET. Sepsis-related VRET decreased to 36% during the intervention period after sepsis alert implementation. During the baseline period, admission sources of VRET varied between ED (most common at 46%), direct admission, perioperative transfer, and ICU transfer (Fig. 4). During the intervention period, only 1 VRET was associated with a direct admission; the remaining VRET arrived from the ED.

Our leading indicator, the percentage of ACT events within 4 hours of admission, did not demonstrate the same level of improvement as our primary outcome VRET metric (Fig. 5). The centerline was 16.8% during the baseline period. Common cause was observed with a modest decrease in late 2018 through 2021, resulting in a centerline of 14.5%.

For our process measure evaluating floor RN assessment of ED patients, we captured data from 97 patients

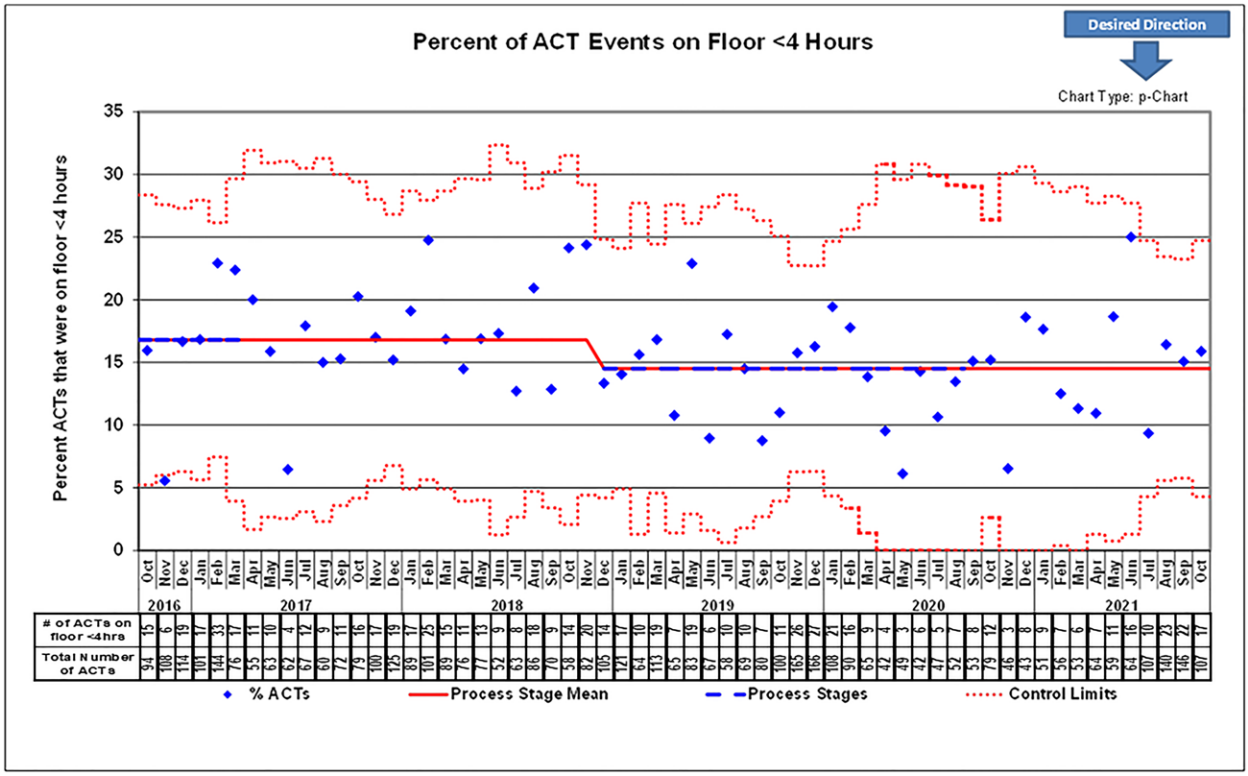


Fig. 5. Statistical process control chart showing the percent of ACT events on the floor in less than 4 hours.

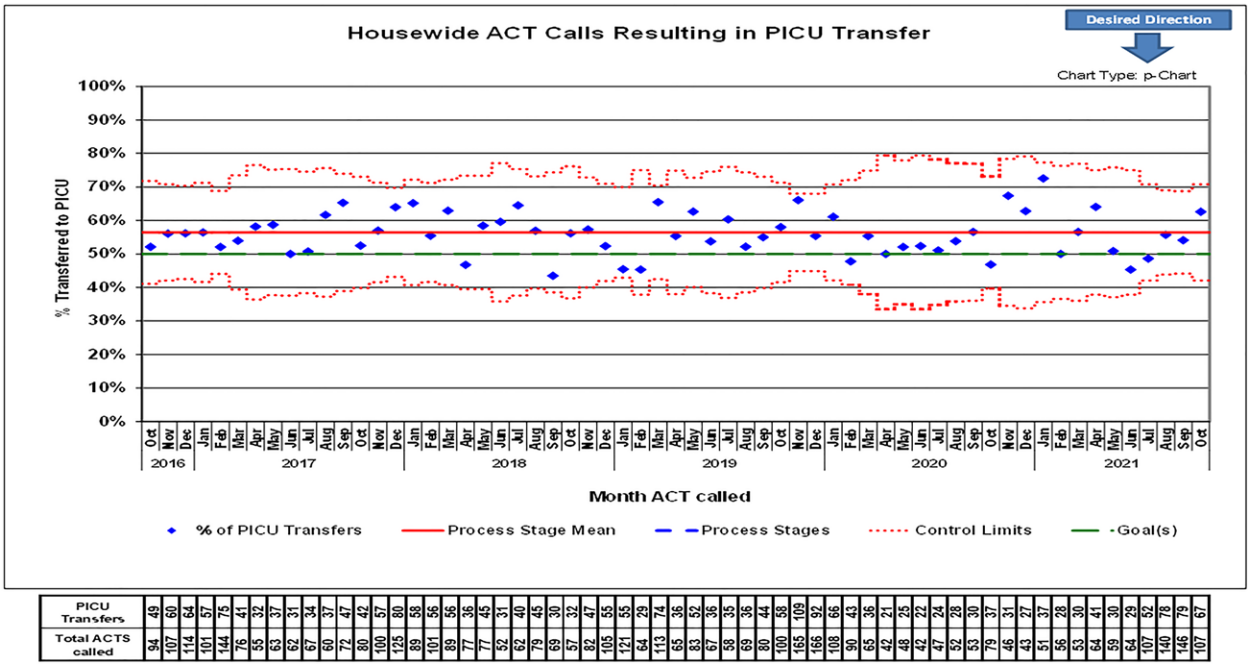


Fig. 6. Statistical process control chart showing the percent of consultation team (ACT) events resulting in the transfer to the intensive care unit.

admitted over 4 months (September 2017–December 2017). Of these, 9 encounters had concerns raised by the floor RN regarding the intended triage disposition to the floor. Two of these patients changed to a PICU disposition, with 1 intubated soon after arrival in the PICU. The improvement team only tracked this process metric for 4 months due to the overwhelming support for the intervention. The pilot general-medicine unit had

3 VRETs during the 6-month baseline period (October 2016–March 2017) and did not experience another VRET during the intervention period through October 2021.

Regarding balancing metrics, the percentage of patients transferred within 15 minutes of the ED RN documenting that care was complete was monitored for 7 months after the intervention. A 2-sample *t* test compared 5 months of preintervention and 7 months of postintervention data, which confirmed the pre- and postintervention values did not differ ($P = 0.755$). For the percent of ICU transfers after ACT, the baseline and intervention centerline was 56.5%, with only common cause variation (Fig. 6).

DISCUSSION

Efforts to reduce the frequency of very rapid emergency transfers (VRET) far exceeded our initial aim of 25 days. A new mean of 79 days between events 6 months after interventions was followed by nearly eliminating VRET, as evidenced by achieving 468 days between events. Reducing VRET was part of our larger goal: ET and code blues reduction through improved situational awareness (SA). Albeit a rare event, our study sample's overall mortality of 12% and our bedside clinicians' passion for decreasing these events compelled us to reduce VRET.

Our interventions focused on recognizing early clinical deterioration, followed by prompt mitigation and escalation. Our improvement had initial success with multidisciplinary interventions sustained by a change in culture, buy-in, and communication targeting VRET prevention—concurrent efforts targeting improved sepsis outcomes aligned with the overarching goal of VRET reduction.

Sepsis is associated with pediatric morbidity and mortality.[19] Prompt recognition and response drive improved outcomes. EHR sepsis screening tools assist clinicians with earlier recognition and team communication.[16,17,19] Concurrent sepsis QI work promoted earlier detection of patient deterioration. Almost 70% of our baseline VRET were attributed to sepsis (Fig. 3, top), compared with only 36% postintervention (Fig. 3, bottom), indicating improvement. Interventions targeted the identification of patients at risk for early clinical deterioration before admission to the inpatient floor. Also targeted were ED and direct admissions, PEWS assessments, earlier vital signs trending, and intentional admitting unit decisions based on unit resources.

Inaccurate admission unit placement, such as a mismatch of patient acuity and unit resources, can result in unplanned transfers to higher levels of care associated with higher mortality and a longer length of stay.[20] For example, Mansel and colleagues reviewed all "rapid" transfers to the PICU within 4 hours of admission and found those patients meeting the ET definition had significantly increased mortality.[11] Other studies have demonstrated higher ET mortality than non-ET transfers, supporting this proximal measure of code blues is important to eliminate.[11,21,22] Though inaccurate admission placement can lead to VRET, we also recognize patients can experience rapid disease progression once admitted, thus the importance of situational awareness to identify and mitigate clinical deterioration at a system level.

Baseline data presented an opportunity to engage ambulatory colleagues in reducing VRET by ensuring appropriate direct admission placement. Direct admissions are important in decreasing ED utilization,[23] but there are inherent risks if the admitting unit's resource capacity does not match the patient's clinical status. Our baseline data revealed direct admissions were associated with a third of the VRET. We developed a direct admission vital sign and assessment algorithm stressing communication with the inpatient team (**SDC 2, http://links.lww.com/PQ9/A479**). Direct admissions were not recommended for certain high-risk patient populations (ie, bone marrow transplants).

We leveraged the SOD role created to support the Watcher Program to mitigate VRET risk by automating notification of new Watchers, including newly admitted at-risk patients. This streamlined communication to the SOD promotes timely risk awareness.

Sustaining the pilot of the inpatient unit nurse in-person patient assessment while in the ED contributed to eliminating VRET. This intervention leveraged the previously established role of this unit's "care partner," an experienced nurse without a patient assignment who assists with various workflows, including patient assessments. This role allowed flexibility in leaving the department to assess incoming patients in the ED. Initially, the care partner attempted to evaluate any admission from the ED but later focused on patients at risk for sepsis or respiratory distress. Anecdotal reports suggested this intervention improved ED-to-inpatient collaboration and communication between RNs. More importantly, this intervention led to at least 1 documented and avoided VRET, which is significant given the high mortality and the rarity of these events. Also notable, there was no change in the balancing measure of ED length of stay, suggesting the additional RN assessment did not lead to system inefficiencies. The pilot unit has not had a VRET since implementing this intervention. Unfortunately, the model was not spread beyond the pilot unit, given constraints in existing staffing models.

Limitations

Rare events are challenging to target for improvement and often require a multidisciplinary and multi-step approach to address the problem. Identifying which interventions made an impact was difficult. Though we had multiple interventions, we only defined 1 process metric, which we tracked for a limited time. Additionally, we do not know the effects the Covid-19 pandemic may have had on the events. Though patient volumes and, thus, opportunities decreased, we experienced 2 centerline shifts before the pandemic. Despite related challenges such as Covid-19 diagnosis, multisystem inflammatory syndrome in

children, isolation protocols, and generalized healthcare staffing crisis, we sustained our improvements. In 2021, our volumes were near prepandemic without a return of events. This work may not be generalizable to organizations without a strong QI culture and clinical informatics resources.

CONCLUSIONS

This study identified a subset of emergency transfers that required different strategies to reduce and nearly eliminate the event type. Targeted efforts to dramatically reduce very rapid emergency transfers were successful; continued vigilance, ongoing event review for learning and action, and future interventions utilizing QI methodology will be important to sustain this endeavor. In addition, future quality improvement work will involve predictive analytics to identify at-risk patients better and incorporate knowledge from colleagues at other hospitals working to eliminate similar events at their organizations.[24]

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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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