





system analysis. The area with the most opportunity for improvement was the discharge process. The team then targeted the discharge process to create capacity for patient throughput to reduce the hospital’s ALOS. The project team proceeded with a structured approach to change management within the discharge process as the first phase of change and set a target of generating situational awareness. The second phase of change focused on improving the efficiency of the discharge process through waste reduction. The third phase improved the efficacy of the discharge process. The final phase of improvement targeted changing the time of day attending physicians wrote discharge orders. By moving the time, this order was written earlier to enable the unit to prepare for the increased bed demand from increased ED admissions, which typically increase throughout the day until the late evening. A summary of interventions is displayed in the Key Driver Diagram (Fig. 2) and is further detailed below and in the Results section. This project’s global aim was to reduce the ALOS by reducing the time elapsed between the computer entry of discharge orders and the patient’s departure from the unit to <60 minutes 80% of the time.

**Interventions**

**Phase 1: (Intervention 1) Situational Awareness**

The first phase’s primary focus was to generate situational awareness around throughput as a concept, which oriented bedside staff and physicians to discharge patients expeditiously. It allowed room changeover time by the Environmental Service Department and the eventual backfill of these rooms with pending ED admissions. The observed delay with the highest frequency of recurrence

was the lack of a sense of urgency. A daily visual management dashboard (Fig. 3A) rallied clinicians around reducing this delay. It contained discharge process-centric key process indicators that became part of the daily shift huddle. During the huddle, nurses discussed the delays for discharge, focusing on problem-solving to mitigate the recurrence of similar themed problems. This daily visual management was created using the PowerInsight data extraction tool (Cerner Corporation, Kansas City, Mo.) and recorded data on all patients discharged from the specified unit within the last 24 hours and displayed them in tabular and graphical format. We then embedded a feedback loop to capture information on all patients not discharged within the 60-minute window of time after computer entry of discharge orders. This feedback loop contained reasons for delays and was managed by the bedside staff completing the discharges.

**Phase 2: (Intervention 2) Discharge Process Efficiency**

The project team continued using the data gathered from the observations and used the Pareto principle to select the next area of focus. During the observations, excessive walking was noted for various materials and supplies frequently used during the discharge process. The team generated Spaghetti diagrams to capture the staff’s walk paths, recognize patterns frequently walked, and identify the materials gathered and used amidst excessive walking. The team used the seven categories of waste to determine what steps in the process were of value from the customer’s (waiting patient’s and family’s) perspective compared to the identified as waste.<sup>5</sup> The team realized that various supplies were not at the point of use (POU). Single minute exchange

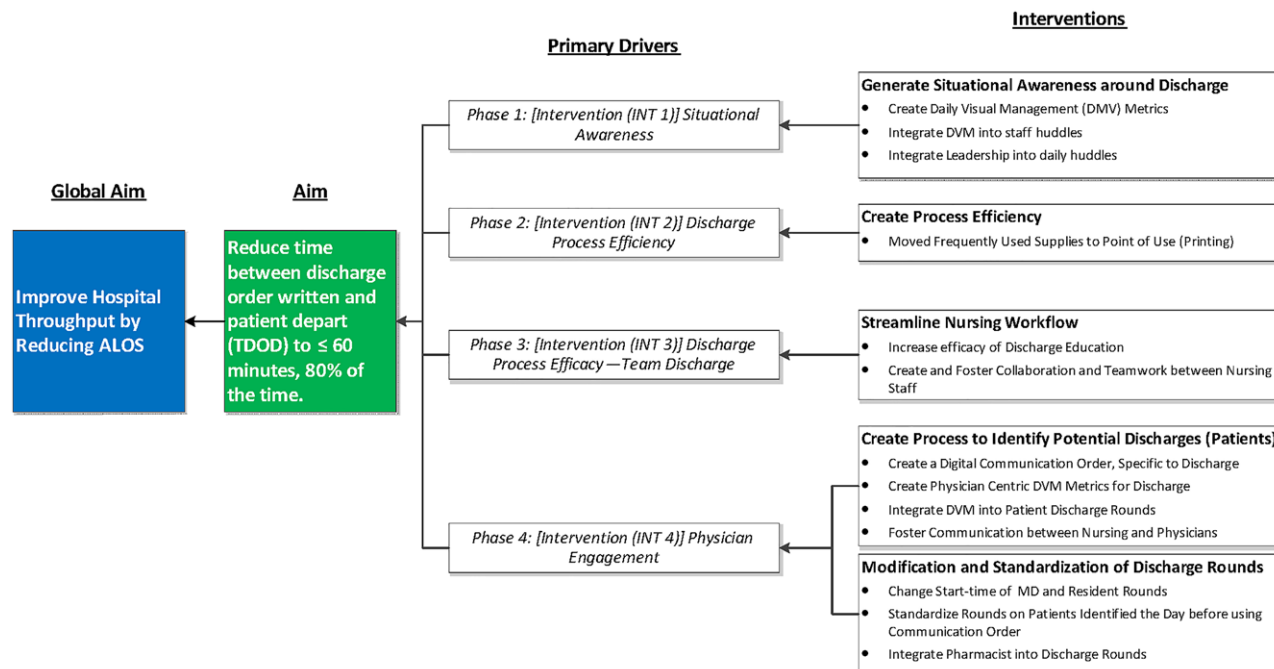


Fig. 2. Key driver diagram detailing the scope of each phase of the project and its relevant interventions.



**Fig. 3.** Daily visual management dashboard (discharge process). A and B. Nursing and physician daily visual management detailing the metrics incorporated into daily huddles to drive change transparently. Upon achievement of the goal compliance, the dashboard changes to green to quickly identify success.

of die methodology was paired with the 5S (sort, shine, set in order, standardize, and sustain) methods to place products at the POU.<sup>5-11</sup> Favorable results occurred on the first MSU. The team scaled this intervention to the second MSU while we continued to analyze the feedback loop in search of additional opportunities for improvement.

**Phase 3: (Intervention 3) Discharge Process Efficacy—Team Discharge**

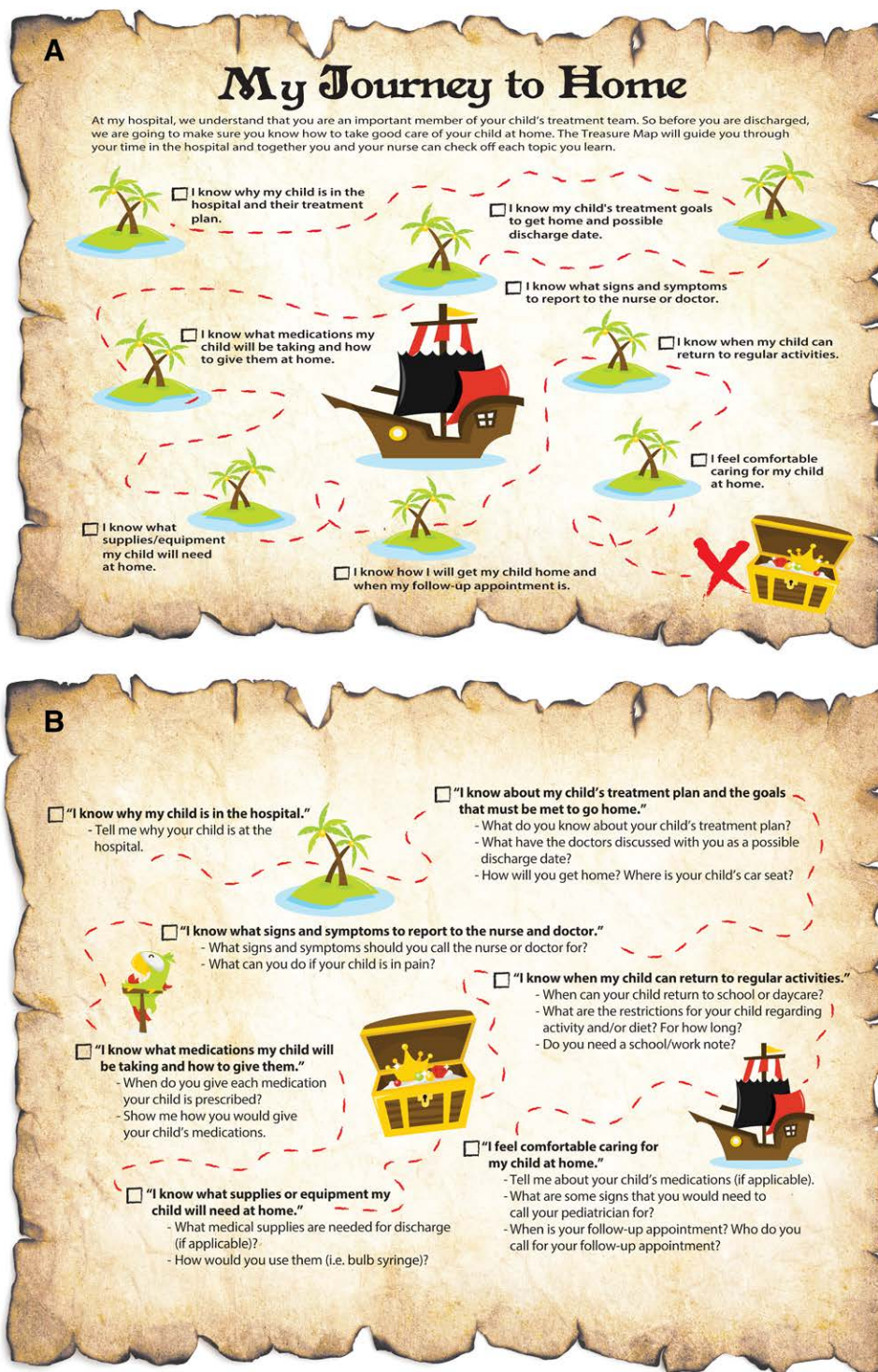
After moving supplies to the POU, the next step was to understand the interactions between the bedside staff (nurses, nursing care partners, and unit secretaries) and the patients/families being discharged. Data from the observations revealed the discharge process to be inefficient. Further review of the larger dataset generated from PowerInsight revealed that patients were returning within 7 days for additional treatment for similar diagnoses, which made the team question the efficacy of our discharge process. *Heijunka* (a Toyota Production System principle for leveling the work) was used to improve the efficiency and efficacy of the discharge process.<sup>12</sup> To complete this, we documented all steps of the discharge process on swim-lane diagrams and the associated time elapsed for each process step. Next, we removed waiting from the process to ensure the continuous flow of value-added work and divided the labor between the unit secretaries, nurses, and nursing care partners. This division of labor allowed them to complete the steps associated with their scope of practice. We then increased the frequency which discharge instruction teaching occurred, from once at discharge to multiple times throughout the hospital stay,

and incorporated teach-back to confirm mastery of the instructions.<sup>13-15</sup> These efforts were completed by incorporating the patient’s parents/guardians into the process with a visual aid (Fig. 4A and B) used as a job instruction (JI).<sup>16</sup> Figure 4A detailed the 7 learning milestones the patient/family should retain before discharge. At the same time, Figure 4B listed the 7 questions that nursing staff would use to guide the discussion and assess the knowledge retained by the patient/family. The division of labor and JI were coupled together and termed “Team Discharge” (Figure 1, Supplemental Digital Content 1, which describes team discharge, <http://links.lww.com/PQ9/A309>). Once the unit secretary announced “Team Discharge,” this process began, which oriented bedside staff to the next patient discharge location. The bedside staff (nurses and nursing care partners) would note the current time and arrive at the patient’s room to complete their assigned task at the appropriate time as part of teamwork. The team scaled interventions to the second MSU after achieving desired results on the first MSU. We began closely monitoring our 7-day readmissions using PHIS data, whereas the nurses continued to update the feedback loop on patients not discharged within 60 minutes of computer discharge order entry. We analyzed the data and found that over half the delays could be resolved by engaging physicians.

**Phase 4: (Intervention 4) Physician Engagement**

With results from the prior interventions attained and sustained, the team shifted focus to creating capacity and capability to improve overall throughput for patients admitted from the ED while simultaneously reducing





**Fig. 4.** Patient, family and clinician job instruction. A and B. Job instruction used to improve the efficacy of discharge. A, It was used by parents/family to identify where they were in the progression of their child's hospitalization and to hardwire teach-back methodology by prompting clinicians with questions. Clinicians used (B) to close the communication loop between parents/family and assess the knowledge retained throughout the hospitalization.

ALOS and readmissions. As part of the next intervention, we used reports generated from PowerInsight, manual observations, and data gathered from the nursing feedback loop to better understand the hour of day discharge orders were entered into the computer and the delays

associated with entering discharge orders earlier in the day. The team also used Pareto analysis to identify which medical service discharged the highest frequency of patients. The analysis identified the hospitalist team as the group that discharged the most patients, so the team focused

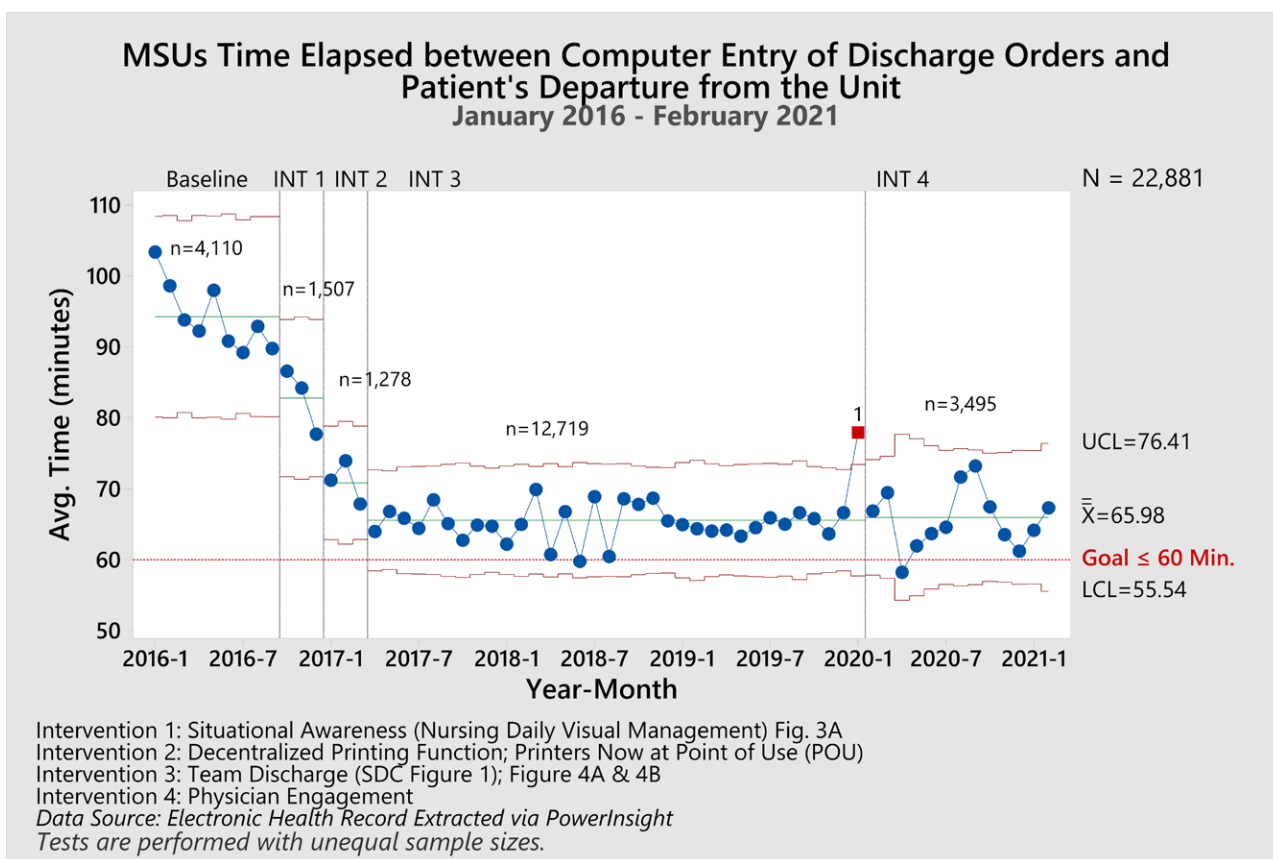
on engaging them with discharge process improvement. To accomplish this, we partnered with the organization's Information Service department to develop a communication order that would invoke the nursing task list, alerting them to prepare the patient/family for an early discharge. The team coupled Spōk technology (Spōk, Springfield, Va.) with the communication order to ensure increased use and ensure it was ordered during evening rounds the day before discharge by sending reminder pages at 14:00 each day. Like nursing, specific to physicians, daily visual management (Fig. 3B) created using PowerInsight visualized the use of the newly designed process. The physician dashboard displayed the percent of discharge orders by noon, compared the progress by medical service, and was posted daily at the POU.

**Data Collection/Measures**

The team used PHIS to benchmark our ALOS data against the other 49 participating pediatric hospitals. Next, the team completed manual observations (time and motion studies) to collect data to understand the bedside staff's work environment, distances walked and the reasons for walking them, as well as the frequency

in which they recurred and the quality of the discharge process from the patient's perspective. The team then completed a measurement system analysis to validate the manual observations by comparing data collected from the Cerner (Kansas City, Mo.) electronic health record. The team used these data to measure and track the overall process, outcomes, and balancing metrics. The PowerInsight data extraction tool (Cerner Corporation) gathered the following data elements for measurement: (1) patient characteristics and demographics; (2) admission and discharge date and times; (3) visit encounter type; (4) discharge order date and times; (5) hospital unit where the discharge occurred; (6) date and times of documented patient education; (7) hospital service of the attending physician writing the discharge order; and (8) return visit information on patients discharged from nursing units included in this quality improvement project.

The team collated all data each month and de-identified it before analysis. This quality improvement project did not meet the criteria for human subject research and, therefore, did not require review and approval by the hospital's affiliated institutional review board.



**Fig. 5.** Xbar SPC displaying the time elapsed between computer entry of discharge orders and the patient's departure from the unit (TDOD). TDOD averaged 94.26 minutes at baseline, and after four interventions, the TDOD averaged 65.98 minutes, a 30.00% decrease,  $P < 0.001$ . Intervention 1: Situational awareness (nursing daily visual management) Fig. 3A. Intervention 2: Decentralized printing function; printers now at POU. Intervention 3: Team discharge (**Figure 1, Supplemental Digital Content 1**, which describes team discharge, <http://links.lww.com/PQ9/A309>); Figure 4A and B. Intervention 4: Physician engagement. Data source: PHIS. Tests are performed with unequal sample sizes.

### Statistical Analysis

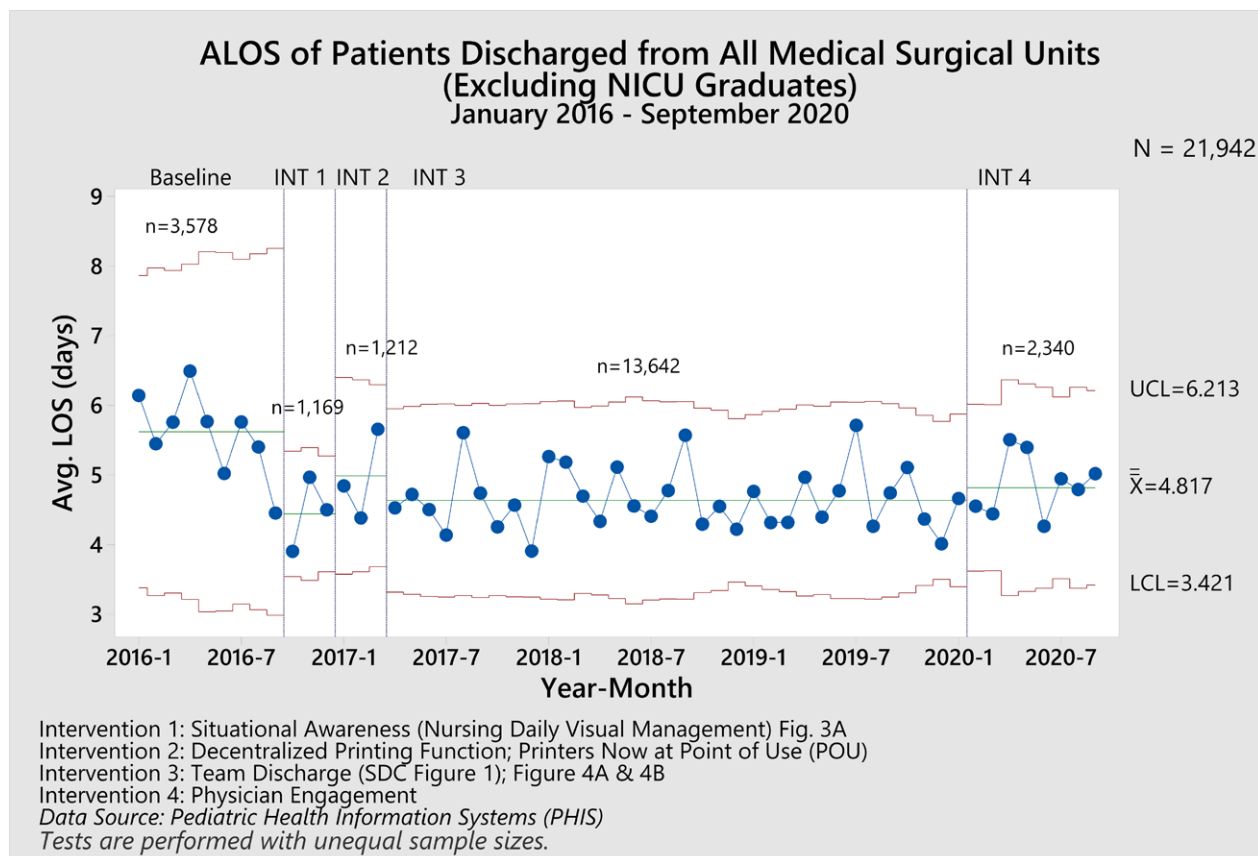
The project team used the data elements mentioned above extracted from the electronic health record and PHIS to create the following variables: (1) time elapsed between the computer entry of discharge orders and the patient's departure from the unit (process measure 1); (2) compliance with discharging patient's within 60 minutes of receiving the discharge order (process measure 2); (3) hospital ALOS (outcomes measure); and (4) return visit rate within 7 days of discharge (balancing measure).

The team analyzed all created variables using Minitab Statistical Software v.16 (Minitab, Inc., State College, Pa.). Control charts measured variability throughout the project. The team performed Wilcoxon Rank-Sum Testing (nonparametric) on time-series data to assess improvements and statistical differences in all time-related process and outcomes metrics. We performed a two-sample proportions analysis to test for significance on all attribute data. Additionally, results were considered statistically significant when the alpha statistic ( $P$  value) was  $<0.05$ . Finally, we established a feedback loop to capture and collate reasons for discharge delays when the time elapsed between the computer entry of discharge orders

and the patient's departure from the unit was greater than 60 minutes, which were, in turn, analyzed for frequency of occurrence using Pareto charts.

### RESULTS

Throughout this study, 22,881 patients were admitted to the MSU. At baseline, patients averaged 94.26 minutes to be discharged from the hospital after a physician had written the discharge order (Fig. 5). After the first intervention (Phase 1: [Intervention 1] Situational Awareness) was implemented, the time elapsed between the computer entry of discharge orders and the patient's departure from the unit decreased by 12.17% to 82.79 minutes. After the second intervention (Phase 2: [Intervention 2] Discharge Process Efficiency), it decreased by an additional 14.43% to 70.84 minutes. After the subsequent intervention (Phase 3: [Intervention 3] Discharge Process Efficacy—Team Discharge) was implemented, the time elapsed between the computer entry of discharge orders and the patient's departure from the unit averaged 65.57 minutes, a total of 30.83% reduction from baseline. Finally, after the last intervention (Phase 4: [Intervention 4] Physician



**Fig. 6.** Xbar SPC displaying ALOS across the 4-phased interventions. ALOS averaged 5.62 days at baseline. After all interventions, the ALOS was 4.81 days, a 14.41% decrease,  $P < 0.001$ . Intervention 1: Situational awareness (nursing daily visual management) Fig. 3A. Intervention 2: Decentralized printing function; printers now at POU. Intervention 3: Team discharge (**Figure 1, Supplemental Digital Content 1**, which describes team discharge, <http://links.lww.com/PQ9/A309>); Figure 4A and B. Intervention 4: Physician engagement. Data source: PHIS. Tests are performed with unequal sample sizes.



Engagement) was implemented, the time elapsed between the computer entry of discharge orders and the patient's departure from the unit averaged 65.98 minutes. Similarly, the compliance with discharging patients within an hour increased from 42.55% at baseline to 60.15%, a 41.36% change after all interventions. Our ALOS (Fig. 6) decreased by 14.41%, beginning at 5.62 days during the baseline phase of this project to a current value of 4.81 days. This process improvement effort improved our position amongst the other PHIS hospitals, from 33rd highest to 22nd, where lower numbers are better (Figure 2, Supplemental Digital Content 2, which PHIS comparison report, <http://links.lww.com/PQ9/A310>). The team tested all process and outcomes measures for significance compared to these data pre and post all interventions, and all *P* values result less than 0.001. Finally, our readmissions rates (balancing measure) decreased slightly without statistical significance *P* = 0.51, beginning at 3.1% at baseline and 2.9% after all interventions were put into place.

## DISCUSSION

A timely, effective, and efficient discharge process was needed to improve throughput and improve patient outcomes, given the diminished bed capacity from renovations, overcrowding, and increased ALOS. To accomplish this, we took the systematic approach to implement improvements, targeting specific MSU, conducting reiterative plan do study acts, and scaling successful changes to other units, rather than focus change management activities on individual diagnoses and diagnosis related groups as other organizations have.<sup>17,18</sup> The team chose this method because we realized it was a systems issue impacting all patients, not just patients with specific diagnoses. Taking this approach to solve the problem would have a more significant impact on alleviating common constraints of throughput like patients boarding in the ED and operating theaters, patients waiting in the ED for care and those leaving without being treated, and EDs going on diversion due to lack of capacity to accept ambulance patients.

Although speed was the focus, patient safety was the guiding principle throughout this project. After patients have been deemed ready for discharge, the prolongation of hospital LOS is associated with increased morbidity, mortality, peripheral intravenous infiltrations and extravasations, and hospital-acquired nosocomial infections.<sup>19,20</sup> There was an expressed focus on mitigating the wait time after the patient was deemed ready for discharge because, during this time, patients on MSU are no longer deemed acute. This designation could potentially cause patient care and coverage to diminish, creating the perfect opportunity for patient harm to occur. We found that one-third of patient adverse events occur during the peak discharge hours, which overlap with the time clinicians are preparing for a shift change, preparing for patient handoff, and during the peak time of receiving new admissions from the ED.

Our organization uses a hybrid methodology for quality improvement to sustain change. It comprises elements from Six Sigma, Lean Healthcare, and the Institute for Healthcare Improvement. This approach focuses on putting the frontline team members in the driver's seat to foster and implement changes while being coached through a rigorous improvement methodology.

## LIMITATIONS

Data and transparency are needed to drive change. One of the limitations of this project was the inability to acquire real-time data from the medical record on discharge times and the percent of patients with discharge orders written by noon. The team believes this would have given the frontline clinicians the ability to calibrate their discharge processes throughout the day as needed based on immediate feedback. We hypothesize resolving this problem if data is provided to the frontline staff as each patient enters the discharge process.

Case Mix Index (CMI) adjusted LOS is the preferred level of complexity desired when benchmarking against other organizations. However, CMI uses the inpatient status encounter type to calculate CMI. We found that our organization's disproportionate amount of observation status patients significantly skews the results of the analysis and grossly inflates the results. Therefore, we disregarded CMI in the benchmarking analysis.

## CONCLUSIONS

This quality department-led, frontline team member-driven process improvement project displays how our organization embodies Lean healthcare values. We allowed the team to surface opportunities for improvement associated with a common themed problem the organization was facing, resulting in the improvement efforts mentioned above. Frontline team members have limitless potential when taught the proper improvement tools and empowered to drive change with senior leadership support. Finally, these efforts exemplify how patient-centered our organization's culture has become by placing parents in the driver's seat of their child's care discussion using the discharge JI and team discharge.

## DISCLOSURE

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

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