ED Care Redesign Project Utilizes Queuing Theory and LEAN Process Analysis in a Pediatric Emergency Department Leads to Improved Quality Metrics and Improved Patient Satisfaction

Rady Children’s Hospital San Diego
3020 Children’s Way
San Diego, CA 92123
www.rchsd.org

Keri L. Carstairs, MD FACEP
Medical Director, Division Chief
Emergency Department
Rady Children’s Hospital San Diego
kcarstairs@rchsd.org
(858) 966-8036

Contact Person:
Jemille Maog
jmaog@rchsd.org
(858) 966-8036

Topical Areas of Focus
- quality improvement
- patient experience

Executive Sponsor and Statement
Irvin A. “Buzz” Kaufman, MD
Senior Vice President, Health Affairs

Emergency Services are an essential function of a health care system. The ability to establish and maintain an effective and efficient Emergency Department (ED) is critical to the overall operation of the system. A successful ED provides access to high quality, timely, and reliable care; creates a welcoming front door for the institution; and, significantly contributes to the fiscal health of the organization. Our ED has recently transformed their operations to sustain dramatic improvements for nearly 2 years with a good of providing high quality, efficient care to the children of San Diego County.
2. Executive Summary (limit 200 words).

Rady Children’s Hospital San Diego is the only free standing children’s hospital in San Diego. We have a large volume pediatric ED with 90% of the market share in our large metropolitan area. We are the only pediatric ED and the only level 1 trauma center for the children of San Diego. Emergency Departments throughout the US, including ours, have experienced increased volume over the past 5 years, with the greatest increases seen in the past 3 years. As demand has outpaced capacity, we struggled to maintain our operational efficiency. This difficulty led to longer lengths of stay (LOS), an increase in the number of patients who left without being seen (LWBS), and reduced patient satisfaction. Data driven decision making and team based decision making improved our metrics to meet and in some cases exceed benchmarks. Improved patient satisfaction scores followed and indicates that the health care service provided to our community is meeting expectations, even during times of surge. The most important aspect of any quality improvement project or institutional transformation is sustainability. Our ED is now able to reliably provide high quality, efficient care to every patient that walks through the door.

3. Background and relevance of the problem being addressed and effort undertaken.

An ED’s responsibility to the community is to reliably deliver excellent, high quality, care to insure the best outcome for every patient. As the front door to an organization, it is critical for the ED to perform well for every patient. In the year prior to our initiative, our ED median LOS at 166.5 minutes and a LWBS rate of 4.5% - both significantly higher than our target goals of 140 minutes, and 2% respectively, and both much higher than national benchmarks. Our inability to provide efficient care was reflected in mediocre patient satisfaction scores, and an estimated loss in hospital revenue of over $1.5 million. With a commitment for change from the CEO and executive team down to the ED leadership and clinical teams, we utilized an organizational team approach to set patient-focused goals.

4. Describe the effort, including the scope, process, strategies and tactics utilized, challenges encountered and how they were addressed.

The ED Care Redesign Project was designed to increase patient ED access and improve quality of care delivered through utilization of Lean flow principles and queuing theory. Demand capacity analysis allowed us to predict our needs particularly during critical high use times. We referenced Whole Systems Measures data to define our benchmark goals to be achieved within a one-year period:

1. Decrease patient LOS to 140 min from our existing baseline of >160 min.
2. Increase patient satisfaction as measured by patients reporting that the quality of their overall care received was excellent by 10% compared to the baseline of 55%.
3. Decrease rate of patients LWBS to <2% from our existing rate of 4.5%.

By critically analyzing ED operations and staffing, utilizing LEAN flow principles and queuing theory we transformed our ED. We did this in the face of a growing mental health population in our ED and one of the worst infectious disease seasons in the past 10 years in FY15 that included influenza, measles, RSV, as well as a national concern for Ebola. Additionally, our annual ED census has increased by 25% over the past 3 years.

LEAN flow principles and queuing theory were used to formulate a new staffing plan. Utilizing demand capacity analysis, we evaluated 4 years of arrival times including patient acuity, and seasonal variations. Direct bedding initiative allowed for immediate treatment, triage, and registration. A charge physician role was created to collaborate with the charge nurse improving communication to ED and hospital leadership. A surge system managed by the charge physician and nurse is utilized for high census. Staffing is reduced for low census. A super-fast-track area is opened to meet the evening demand of low acuity patients to increase ED capacity. An observation unit was
opened for mental health patients until inpatient beds were available or their acute condition stabilized. A daily ED dashboard tracked metrics and immediate improvements were made when needed.

**ED Operations and Staffing**

We examined our frontend process and instituted a process change placing patients directly in beds and performing bedside triage and registration, allowing faster access to providers. We saw immediate improvement in adoption of this new process. An internal ED discharge waiting area was utilized in times of high census to keep our waiting room empty.

The most significant change to ED operations was a completely new staffing plan for both providers and nurses. By utilizing demand capacity analysis and our EHR, we evaluated 4 years of arrival times including analysis of patient acuity. We examined both seasonal and daily variations to more accurately predict patient arrivals. We were able to also decide when a pediatric EM physician, a nurse practitioner or general pediatrician was most needed. The seasonal variation was extremely important because pediatric EDs can have extreme census changes. We analyzed 3 seasons: low, mid, and high demand. We also identified times of the day when an expanded fast-track area and/or additional providers for rapid treatment of low acuity patients was beneficial.

Additionally, to improve communication, we created a system to have a senior pediatric emergency physician function as a charge physician. The charge physician and the ED charge nurse were empowered to solve problems and communicate with ED directors and hospital administration when needed to enact real time interventions. We also created a surge call system, managed by the charge physician and nurse, to bring additional providers when the census was high. Additionally, in times of low census, we also created a system to reduce staffing in real time when needed.

Daily ED dashboard reporting and analysis feedback occurred to make immediate changes. The dashboard was communicated to the executive team and all involved parties including leadership from all departments and health care providers in the ED. We monitor daily census, LWBS, LOS and specific patient population details including lengthy ED stays (>400min), hospital admissions, ICU admissions and trauma patients. We continue to monitor 72-hour return visits.

**Assessment of Mental Health Patients**

Emergency Departments are a critical access point for patients with mental health diseases. Both inpatient and outpatient resources are often unable to meet the needs of these vulnerable patients, and the patients are left to seek care in an ED. The ED often needs to function as a safety net for these patients. Patients who need mental health care challenge the complex flow of the ED and often require more resources than other patients do. Over the past 2 years, our ED census for pediatric psych patients increased by over 25%. The opening of an inpatient psychiatric unit in the hospital further increased the number of behavioral health patients who presented to the ED. Inpatient psychiatric bed capacity was insufficient to meet the increased demand in need of mental health services were often held in the ED for extended periods. Our institution recognized that the ED is a suboptimal environment for ongoing treatment of patients with acute mental illnesses and responded by opening of an observation area for these patients. This area functioned to hold patients until beds were available or the patients’ condition stabilized and a care plan could be made.

**Patient Satisfaction**

Patient satisfaction surveys are conducted by an independent survey group providing monthly data on overall quality of care and individual aspects of care. We accessed these monthly reports for the calendar year prior to implemented staffing changes and continue to monitor these reports.
Monthly Hospital Data

Hospital dashboard data was collected to compare the calendar year time periods for total ED patients seen, LOS, LWBS, and financial reports. These data were compared to evaluate the effectiveness of ED changes.

The ED Care Redesign task force utilized the input of family members to assess the impact of its interventions. ED families are included in the patient satisfaction survey conducted by PRC. Family satisfaction threshold scores are included into the management goals of the hospital’s managers, supervisors, directors, and administrators. Additionally, we obtained direct design feedback and input from the 12 families represented by Family Advisory Council, and to the 4 family members included on the Quality Safety Medical Affairs Committee of the Board of Directors. The organization’s performance in these domains has been regularly reported to the hospital and medical staff leadership, as well as to the Quality Committee of the Board.

While recognizing that no two organizations are fully comparable, the availability of benchmark data helped to define the magnitude of the opportunity for improvement, and provided the impetus for change. The benchmark data was specifically used to define operating plan goals for the organization. In addition, the identification of top performing organizations provided the important opportunity for collaboration, and the identification of best practices.

5. Describe the results of the effort.

Immediate ED change in a fluid patient population

The ED operational changes began in November 2014 and resulted in almost immediate positive changes during a time when our census continued to increase. The ED census was greater than 90,000 in the most recent fiscal year, representing a continued annual growth of 15%.

Increased direct bedding

We have improved “direct bedding” from a baseline to 19% to 87.1% in the most recent month with median of 63% in FY15 (post change) and 82.1% in FY16 of all patients who arrived to our ED. We were also able to improve our staffing to the optimal level and meet the increasing demands. We were successful in achieving and in most cases, exceeding our initial goals. Our door to provider times are consistently below 30 minutes.

Decreased rate of patients who left without being seen

In the year previous to our interventions, our LWBS rate was 4.5%. Once the staffing and ED changes were initiated, this rate decreased immediately and was has been sustained to a consistent level less than 1%, demonstrating our models ability to decrease LWBS while accommodating our increasing overall patient census. These results exceeded out goal of decreasing LWBS patients to ≤2% (Fig. 1). In relation to the post-program change period, patients seen in the corresponding pre-program change period were 5.9 times more likely to have left the hospital without treatment (95% CI – 5.5, 6.2).
Decreased ED LOS

Median ED LOS failed to meet the 140 minute benchmark for 100% of the comparison months prior to the ED staffing and program change. Median ED LOS decreased significantly once changes were initiated ($p<0.0001$) and is substantially lower than the benchmark. By way of comparison, the CHA Whole System Measure median LOS was most recently calculated and reported as 161 min, with a top quartile benchmark of 132 min. FY 15 year end LOS was 135 min and FY16 was 128 min (Figure 2).
**Patient Satisfaction Scores**

Overall, patient satisfaction scores increased significantly. For the year prior to the staffing changes, our patient satisfaction scores only met the benchmark goal of 65% excellent rating during one month (8.3%). Since staffing changes were made, overall quality of care met or exceeded our goal of 65% excellent ratings in 67% of the months (p = 0.001) (Figure 3). Months when we fail the 65% overall excellent benchmark are often associated with unanticipated patient surges, something we continue to try to improve.

**Fiscal Benefits**

The dramatic reductions in the rate of patients who left without being seen resulted in substantial financial gains for both the hospital and physician group. Applying an estimated $500 potential loss per patient, resulted in a substantial difference in the amount of potential revenue lost for the hospital since changes have been implemented. By lowering the LWBS rate, the institution was estimated to have increased its revenue by over $3.3 million cumulatively from November 2014-June 2016. (Figure 3). The physician group was able to simultaneously realize an comparable increased wRVU production. Nursing productivity improved from the previous year by 7.2% and expense per unit of service decreased by 3.6%.

![Figure 3. Rady Children's ED Additional Revenue Since November 1, 2014](image-url)
Better Access to and Treatment of Mental Health Patients

Due to the addition of a mental health observation unit, we were able to improve the care of mental health patients while also improving ED capacity. Since opening this unit, we have saved 1740 bed hours of ED care and 46% of these patients could be discharged home from this area, thereby saving inpatient beds for other patients. We continue to utilize this area for these patients as it is proving to be a sustainable solution.

6. Discuss the significance of the results. How do the results demonstrate outstanding achievement?

The changes that were tested and improved patient flow by increasing the EDs patient capacity, aligning staffing to patient demand, aligning patient acuity with resource requirements, reducing or eliminating waste (such as wait times), improving reliability, facilitating discharge from the ED, and information management. We also improved patient and family satisfaction. Additionally, substantial financial gains were realized.

7. Describe sustainability and scaling of the achievements.

Patient flow through the ED was recognized to be modulated by internal and external variables. The ED flow committee was designed to be multidisciplinary. This breadth of expertise permitted a comprehensive approach to improving the patient flow. For example, ED behavioral health patients were frequently held for extended periods of time while they were waiting for placement. These extended wait times adversely affected the delivery of effective care and treatment, as well as restricted the flow of all ED patients. The goals of optimal care of the patient and ED flow were intertwined. The committee recommended and oversaw the implementation of a separate mental health observation. This unit had the simultaneous impact of improving patient care, increasing ED bed capacity, and improving patient flow in the ED.

The ED flow committee recognized that ED patients requiring sedation experienced extended boarding times due to the constraints imposed by existing workflows. Use of alternative sedation agents was implemented avoiding the requirement for extended NPO periods. These modifications permitted patients to more quickly obtain definitive treatment while at the same time increasing ED bed capacity and improving ED flow. Here too, as boarding times were reduced, bed capacity in, and flow through the ED was improved.

A current focus of the committee is evaluation of the wait times experienced by patients being admitted to the inpatient units. Existing work flow designs are being evaluated, and the impact of creating an RN position devoted to expediting inpatient admissions is currently being evaluated.

The challenge of managing patient flow through the ED is not new, and for us, required a fresh, multidisciplinary approach. To emphasize the importance of the work of the committee and to ensure goal alignment across the organization, in FY 2015 the executive team and the hospital’s board stipulated that all of the organization’s leaders had a portion of their merit compensation linked to improved ED patient satisfaction scores. Regular updates to the Board of Trustees, the Quality committee of the Board, and to the Family Advisory Council ensured that the improvement work remained focused and highly visible.

The availability of accurate and timely data was recognized as the lifeblood for change and fostered collaboration between the ED flow committee, Information Technology (IT), Quality Management, and Finance in the selection of quality metrics. Data abstracted from the electronic health record enabled the flow committee to proactively predict the needs of our patients, and to optimize the design of patient workflows. The input provided by the organization’s industrial engineers was invaluable in guiding this work.
8. Describe key lessons learned and any advice to colleagues who might try to undertake a similar effort.

Although many factors were critical to the success of this QI project, lessons that stand out. Alignment throughout the organization and an almost crisis level of attention by executive leadership led to extreme focus and deliberate action. Other factors that contributed to the project’s success were the inclusion of all involved stakeholders in the decision making process; the use of established improvement methodologies with clearly identified aims and measures; the availability of accurate, and timely data; and the availability of experienced industrial engineers to help look at both the process and help turn the thousands of data elements into useful information. Finally, in organizations with multiple competing priorities, the importance of a core group of “Champions” who are able and willing to drive the change process with passion and energy cannot be overstated.