Waterfalls and Handoffs: A Novel Physician Staffing Model to Decrease Handoffs in a Pediatric Emergency Department

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Study objective: Patient handoffs at shift change in the emergency department (ED) are a well-known risk point for patient safety. Numerous methods have been implemented and studied to improve the quality of handoffs to mitigate this risk. However, few have investigated processes designed to decrease the number of handoffs. Our objective is to evaluate a novel attending physician staffing model in an academic pediatric ED that was designed to decrease patient handoffs.

Methods: A multidisciplinary team met in August 2012 to redesign the attending physician staffing model. The team sought to decrease patient handoffs, optimize provider efficiency, and balance workload without increasing total attending physician hours. The original model required multiple handoffs at shift change. This was replaced with overlapping "waterfall" shifts. This was a retrospective quality improvement study of a process change that evaluated the percentage of intradepartmental handoffs before and after implementation of a new novel attending physician staffing model. In addition, surveys were conducted among attending physicians and charge nurses to inquire about perceived impacts of the change.

Results: A total of 43,835 patient encounters were analyzed. Immediately after implementation of the new model, there was a 25% reduction in the proportion of encounters with patient handoffs, from 7.9% to 5.9%. A survey of physicians and charge nurses demonstrated improved perceptions of patient safety, ED flow, and job satisfaction.

Conclusion: This new emergency physician staffing model with overlapping shifts decreased the proportion of patient handoffs. This innovative system can be implemented and scaled to suit EDs that have more than single-physician coverage. [Ann Emerg Med. 2019;73:248-254.]

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INTRODUCTION

The risks associated with handoffs have been well documented.[1-3] The Accreditation Council for Graduate Medical Education,[4] The Joint Commission,[5] the World Health Organization,[6] and the Institute of Medicine[7] recommend focusing on improving handoff processes to improve patient safety. The emergency department (ED) is often a patient's entry into the medical system. Miscommunication and misinformation that start in the ED may affect a patient's inpatient and outpatient care. In studies evaluating ED shift-change handoffs, critical vital signs were not communicated for up to 74% of patients[1] and errors or omissions were observed in 58% of handoffs.[2] In regard to ED to inpatient transfers, almost one third of ED staff reported an adverse event or near miss after transfer that could be attributed to inadequate communication between the ED and inpatient team.[3]

There are 2 main approaches to mitigate the risk of handoffs. One is to improve the quality of handoffs and the other is to decrease their number.[8] Numerous methods have been implemented and studied to improve the quality of handoffs. However, few have investigated processes designed to decrease the number of handoffs.

Standardizing handoffs through the use of templates,[9,10] handoff mnemonics,[11,12] and handoff bundles[13,14] have reduced handoff-related care failures. Increasing and improving use of technology by implementing computerized sign-out systems[15] have also been proposed as methods to improve handoffs. Limiting interruptions and distraction by performing handoffs in a quiet and dedicated space and decreasing redundancy by having

Editor's Capsule Summary

What is already known on this topic

Patients transferred from one physician to another are at increased risk of adverse events in the emergency department (ED).

What question this study addressed

Does a new, overlapping, emergency physician staffing model decrease the proportion of handoffs in the ED?

What this study adds to our knowledge

This quality improvement retrospective study demonstrated a 25% decrease in the probability of patients' handoff after the implementation of a new overlapping staffing model in a tertiary care pediatric hospital.

How this is relevant to clinical practice

This study demonstrated that an overlapping staffing model may have a positive effect on patients and physicians.

multidisciplinary handoffs have also been suggested as solutions.[16,17] For pediatric EDs specifically, recent studies demonstrated that a structured handoff tool improved the completeness of information conveyed[18] and that checklists improved quality of care, improved team communication, and identified patient safety events.[10] In all of these cases, additional resources are required to create the appropriate infrastructure, to provide time for the providers to learn the tools, and to ensure that the improvements are sustained.

One common approach to decrease the number of intradepartmental handoffs in the ED is to increase staffing by adding fast-track providers to treat lower-acuity patients. In theory, these additional providers decrease the patient load for other providers, leading to fewer handoffs within the ED. However, these solutions require additional providers and increase cost. Overlapping shifts have also been proposed as a way to decrease handoffs,[8,19] but to date, there have been no published studies to our knowledge on implementation of a novel staffing model to decrease the number of handoffs in the ED.

Seattle Children's Hospital implemented a new physician staffing model in April 2013. The model was designed to decrease patient handoffs, optimize provider efficiency, and balance workload without increasing total attending physician hours. The aim of this study was to evaluate the effect of this novel model on the percentage of patient handoffs that occurred in an academic pediatric ED.

MATERIALS AND METHODS

This was a retrospective quality improvement study evaluating the effects of a novel physician staffing model in a pediatric academic ED on intradepartmental patient handoffs.

Seattle Children's Hospital is a 350-bed pediatric academic medical center that serves the Pacific Northwest and provides care to pediatric patients in Washington, Alaska, Montana, Wyoming, and Idaho. The 38-bed academic ED currently has an annual volume of 46,000 patients, with an admission rate of approximately 20%. The ED volume in 2013 was 34,813. Approximately 70% of the patients are high acuity (level 1, 2, or 3) by the Emergency Severity Index triage scale. There is 24-hour coverage in the ED and 56 hours of attending physician coverage per day (seven 8-hour shifts). It is staffed by pediatric nurse practitioners, as well as residents from pediatrics, emergency medicine, and family medicine. Medical students (third and fourth year) also participate in providing care. They are supervised by pediatric emergency medicine fellows and attending physicians. There is also a parallel fast-track system staffed 8 hours daily by general pediatricians.

The original model had 3 zones that required handoffs at the end of each shift (Figure 1). Each shift was 7 to 9 hours long. At shift change, the outgoing and incoming physician would sign out the entire list of patients. This process was challenging not only because of the sheer number of patients, but also because of numerous interruptions from staff, outside telephone calls, and patient deterioration. After handoff, the outgoing attending physician would stay for a few hours to finish charting. The incoming attending physician would assume care of patients whom they received during sign-out, attend to the issues that arose during the handoff period, and start treating new patients.

Interventions

A multidisciplinary team met in August 2012 to redesign the attending physician staffing model. The team sought to decrease patient handoffs, optimize provider efficiency, and balance workload without increasing total attending physician hours. The new model works as follows: there are 2 zones with overlapping "waterfall" shifts. On arrival to the ED, the attending physician is in a "primary" role. The next attending physician arrives 3 to 5 hours later, assumes the "primary" role, and immediately starts treating new patients. The first attending physician transitions to a "secondary" role and completes work on existing patients while treating new patients with less complex disease (Emergency Severity Index scores 4 and 5),

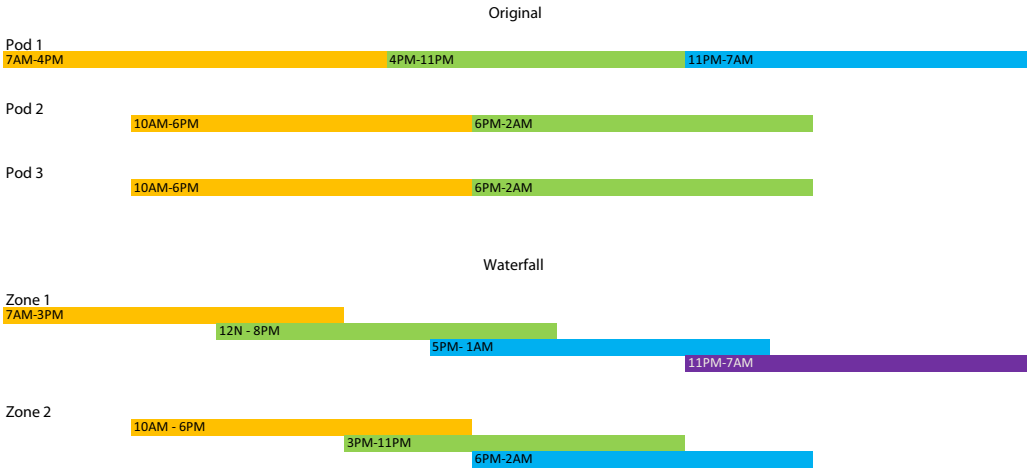

Figure 1. Shifts in original versus waterfall model.

with the intention of being able to treat and discharge them before the end of the shift. At the end of the shift, any remaining patients are signed out (Figure 1). With overlapping shifts and change in patient care prioritization, the goal was to decrease the number of patients who require handoff at the end of the first attending physician's shift, and if handoffs had to occur, they would be for patients with less complex disease, as determined by chief complaint and Emergency Severity Index score.

Once the model was designed, the team approached all attending physicians individually to review the new model. The topic was also discussed several times at division meetings to ensure that all concerns and questions were addressed.

This was a quality improvement study of a process change in an academic pediatric ED that evaluated outcomes before and after implementation of a new, novel, attending physician staffing model. Patients treated in the ED between December 2012 and April 2014 were included in the study.

A 5-level Likert scale survey was sent to attending physicians and charge nurses who worked in the ED before and after the waterfall staffing model was instituted to assess their perception of patient safety, ED flow, and job satisfaction. The questions were developed by the authors to obtain qualitative data in regard to the new schedule. The survey was sent out in October 2016 and remained open for a 2-week period.

Methods of Measurement

The primary outcome was the percentage of handoffs that occurred between ED providers. The numerator was the number of charts that had 2 or more pediatric emergency medicine attending physician signatures in the electronic medical record. The denominator was the number of patients treated by pediatric emergency medicine attending physicians per week. Charts with 2 or more attending physician signatures were chosen as a proxy for handoffs because, if the patient needed further evaluation and management by the second attending physician, there would be documentation of the physician's decisionmaking and intervention. Patients with mental health diagnosis as their primary diagnosis were excluded from analysis because of the unique multidisciplinary approach and often prolonged evaluation required for this patient population. Lower-acuity patients treated by fast-track physicians were also excluded from analysis.

Balancing measures included median length of stay for all patients, percentage of charts completed within 72 hours after patient checkout, family experience survey scores, resident education experience survey scores, 72-hour return rates, and rates of leaving without being seen. The preintervention period was from December 1, 2012, to April 22, 2013, and the postintervention period was from April 23, 2013, to April 30, 2014.

Primary Data Analysis

Statistical process control was used to evaluate the effect of the interventions over time. It is a quality improvement research methodology that uses Shewhart (control) charts to evaluate variation in processes over time. Control charts are used to distinguish variation in a process owing to common causes (ie, random variation) and variation owing to special (assignable) causes.[20] Chart types are selected according to the type of data to be analyzed (continuous versus count/classification).

A control chart contains a centerline and upper and lower control limits that are statistically defined and are

generally approximately 3 SDs above and below the centerline value. Specific rules have been established to identify special cause on a control chart. These include a single point outside the control limit, a run of 8 or more points in a row above or below the centerline, 6 consecutive points increasing or decreasing, 2 out of 3 consecutive points in the outer third of a control limit, and 15 consecutive points close to the centerline. Control charts in this study were created with the quality improvement Charts add-on for Excel (version 2.0; Process Improvement Products, Austin, TX). For the balancing measures, the length of stay and resident education experience survey scores were calculated as medians. The percentage of charts completed within 72 hours after patient checkout, family experience survey scores, 72-hour return rates, and rates of leaving without being seen were calculated by the 2-sample test for equality of proportion with continuity correction.

This quality improvement project was granted exempt status by the Seattle Children's Hospital institutional review board.

RESULTS

A total of 43,835 patient encounters were analyzed. The attending physician staffing model was implemented on April 23, 2013. For the primary outcome of patient handoffs, there was special cause variation, with a downward shift (8 points below the centerline) after implementation of the new staffing model, resulting in a 25% reduction in patient handoffs, from 7.9% to 5.9% of patient encounters. This decrease in handoffs was sustained throughout the study period (Figure 2).

For balancing measures, there was a slight increase in the median patient length of stay, from 2.82 hours (interquartile range 1.79 to 3.85 hours) to 2.87 hours (interquartile range 1.71 to 4.03 hours), a difference of 3 minutes. The percentage of charts signed within 72 hours improved from 90.4% to 95.7% (difference 0.053; 95% confidence interval 0.05 to 0.06). There was no significant change in the family experience survey scores or resident education experience survey scores. There was improvement in the rate of leaving without being seen, from 0.48% to 0.31% (difference 0.0017; 95% confidence interval 0.0004 to 0.0030), and the 72-hour return rate, from 4.97% to 4.36% (difference 0.0061; 95% confidence interval 0.001 to 0.011) (Table). The average Emergency Severity Index score changed during the study period, from 3.198 to 3.065, indicating that the acuity of patients increased, given that lower Emergency Severity Index score is associated with higher acuity. There was one serious safety event before the change and one after the change that were attributed to the ED.

In the survey sent out to attending physicians and charge nurses who worked in the ED before and after the

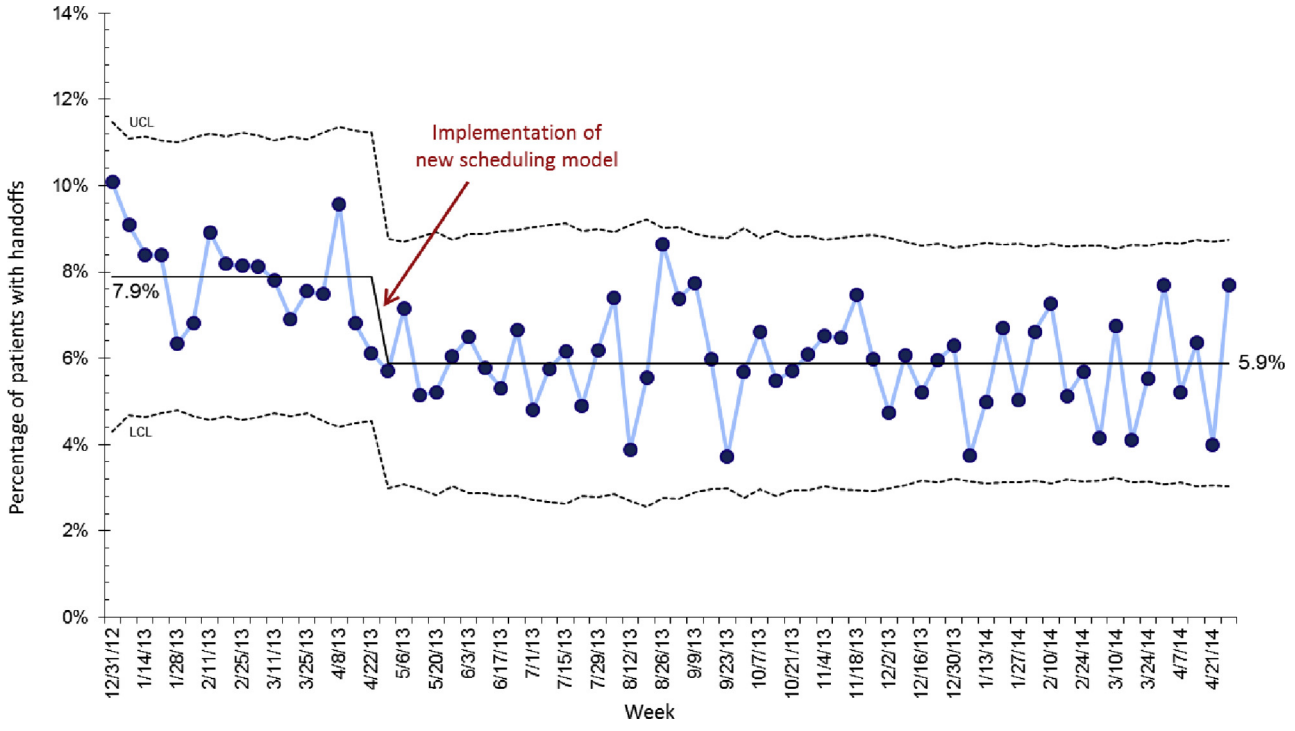

Figure 2. Percentage of patients with handoffs by week.

Table. Balancing measures.

Balancing Measure	Median	Q1	Q3	IQR
LOS in old model, h	2.82	1.79	3.85	2.06
LOS in waterfall model, h	2.87	1.71	4.03	2.32
Overall quality of teaching sessions (1–5 scale) in old model	5	4	5	1
Overall quality of teaching sessions in waterfall model	5	4	5	1

	Percentage in old model	Percentage in waterfall model	Difference	95% CI
Charts signed within 72 h, %	90	96	5	0.05 to 0.06
Families answering "usually" or "always" to confidence in providers question, %	94	95	1	−0.05 to 0.03
Rate of leaving without being seen, %	0.48	0.31	−0.17	0.0004 to 0.0030
72-h returns as % of discharges, %	4.97	4.36	−0.61	0.001 to 0.011

LOS, Length of stay.

institution of the new waterfall staffing model, all agreed that the model subjectively improved patient safety.

Eighteen of 24 attending physicians (75%) responded to the survey. In response to the question "the waterfall attending physician staffing model improved patient safety," 12 physicians (67%) responded that they strongly agreed and 6 (33%) responded that they agreed with the statement. In response to the question "the waterfall attending physician staffing model improved my job satisfaction," 15 physicians (83%) responded that they strongly agreed and 3 (17%) responded that they agreed with the statement. Comments followed 2 themes: better decision making capacity and improved job satisfaction. These providers' comments noted improved cognitive workload and functioning, including "reduced sign outs and focusing decision making at the start of the shift is definitely a plus," "helps focus work and provide relief for many of the shifts," and "the coverage helps to ensure a rested and refreshed colleague comes at staggered times."

In regard to improved job satisfaction, comments included "the staffing model is, in my opinion, the single most important change we've made in terms of contributing to attending job satisfaction" and "the difference is amazing and undeniable. Rather than taking over a whole roster of patients, I will typically only take over 1-3 of my colleague's patients at sign out. Also, knowing that I will run for 5 hours and then have a breather with time to eat and go to the bathroom when my waterfall partner arrives is a savior" (Appendix E1, available online at http://www.annemergmed.com).

Thirteen of 18 charge nurses (72%) responded to the survey. In response to the question "the waterfall attending physician staffing model improved patient safety," 8 nurses (62%) responded that they strongly agreed and 5 (38%) responded that they agreed with the statement. In response to the question "the waterfall attending physician staffing model improved ED flow," 8 nurses (62%) responded that they strongly agreed and 5 (38%) responded that they agreed with the statement. Comments included "I think the waterfall helps patients get seen a little faster. It decreases the time patients are sitting and waiting for the next on-coming attending." "Great idea—we hardly notice any change of hands now and it has improved flow immensely" (Appendix E2, available online at http://www.annemergmed.com).

LIMITATIONS

This study was conducted in an academic teaching institution with robust attending physician coverage. This may limit generalizability to institutions with more limited staffing, such as community hospitals. In addition, to maximize efficiency and to be able to evaluate patients, there must be enough patient care spaces to allow incoming providers to treat new patients. This may be challenging in EDs that have fewer beds. This was also a retrospective study that used the electronic medical record system; therefore, not all types of handoffs may have been captured. However, this variability existed before and after the intervention. A handoff was defined as charts that included 2 or more attending physician signatures. Attending physicians are expected to chart on patients they receive during handoff, especially if there are clinical decisions or changes that occur. Attending physician documentation practice may vary and therefore there may be some handoffs that were missed. However, given that these are aggregate data and the provider group did not change before or after the intervention, those variations would be present throughout the study period.

Another limitation is that the change to the attending physician staffing model occurred simultaneously with a move to a new physical space. Although it is challenging to separate the effect of the 2 changes on handoffs and provider satisfaction, the new ED has more beds and a larger footprint and was not designed with the intention to reduce handoffs. Also, the provider satisfaction survey was conducted 2 years after the change of the schedule. As a result, it may be affected by selection and recall biases. However, it does add perspective and insights in regard to the novel schedule.

DISCUSSION

Handoffs, or transitions of care, are a well-known risk point leading to patient harm, particularly in the busy ED environment.[21,22] Decreasing the percentage of handoffs that occur between ED attending physicians through the new staffing model leads to fewer opportunities for miscommunication and errors and therefore better patient safety and care. In addition, the ED is a complex and demanding place to work, filled with many interruptions and interactions with a large number of people, which can be cognitively strenuous.[23-26] It has been shown that excessive cognitive workload and increased stress negatively affect performance.[27] This may also affect provider morale, satisfaction, and career longevity.

The original model had several pitfalls. From a patient safety perspective, multiple patients had to be handed off to the incoming attending physician, providing multiple opportunities for communication errors and omissions. Patient care was delayed during the handoffs because trainees and nurses had to wait to discuss patients with the attending physician. This had the potential to lead to patient harm. Attending physicians were working at full capacity during their entire shift and often staying late to finish charting. Sign-out was stressful to give and receive, especially at peak patient arrival times, when patients would continue to arrive while the handoff was in progress.

The new physician staffing model attempted to address the aforementioned issues by decreasing the proportion of handoffs between emergency physicians while maintaining the same number of total physician hours. There was no need for additional training or education because it did not affect the existing work flow for emergency physicians and staff. One response summarized the impact of the new model well: "[There are] fewer handoffs and those handoffs I had were less complicated and I had more time to tie up loose ends with another attending [physician] taking new patients."

In addition to being able to provide better care for patients, the majority of attending physicians preferred the new model. A survey of physicians and charge nurses showed improved perception of patient safety, ED flow, and job satisfaction. When the provider transitions from the primary to secondary role, there is an opportunity for him or her to take a short break. The arrival of the next physician improved not only provider morale, but also staff morale because new attending physicians arrive every 4 to 6 hours, ready to treat new patients. Providers reported increased ability to leave on time and complete charts before the end of their shift. There were also more opportunities to collaborate and interact with other physicians. All of these changes may lead to improved quality of life and career longevity. One attending physician commented, "Love it! Has added longevity to my career."

There was a minimal 3-minute increase in the median length of stay for all patients, from 2.82 to 2.87 hours. Although there was an increase, 3-minutes is not clinically significant. Furthermore, such delays are frequently due to external factors such as availability of inpatient beds, of staff to transport patients, and of inpatient providers or nurses to receive sign-out. There was no significant change in family experience survey scores or resident education experience survey scores, suggesting that families and trainees did not experience any negative effect from the change. There was improvement in the percentage of charts signed within 72 hours, which may be due to providers having more time to finish managing their patients and to complete their charting during their shifts. There was also improvement in the rate of leaving without being seen and the 72-hour return rate, which suggests that safer care was being delivered because patients were not leaving without being evaluated by providers and fewer patients were returning to the ED within 72 hours. However, the pre-intervention period was during the high-volume, high-acuity winter months, whereas the post-intervention period included a longer period with the lower volume, lower-acuity summer months, which may have affected the data. Patients treated per shift increased proportionally to the increased census, so the average number of patients treated per hour increased during the study period for all shifts.

This innovative emergency physician staffing model decreased the percentage of patient handoffs, potentially leading to improved patient safety. Attending physicians and charge nurses reported improved perceptions of patient safety, ED flow, and job satisfaction. This innovative system could be implemented and scaled to suit EDs that have more than single-physician coverage. Further research is needed to quantify how this novel staffing model affects patient safety and how it can be successfully implemented in other care settings.

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