A Tool for Improving Patient Discharge Process and Hospital Communication Practices: the Patient Tracker

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Abstract
Hospital bed demands sometimes exceed capacity, leading to delays in patient admissions, transfers and cancellations of surgical procedures. Effective strategies must be in place for an efficient use of existing beds. Establishing such strategies at academic hospitals poses serious challenges. We developed and implemented a web-based software application called “Patient Tracker” to manage the discharge process, minimize delays in admission and reduce surgical procedure cancellations. We also tested the effectiveness of the software on the workflow by comparing outcomes between the pre-implementation control group (2002-2003) and the post-implementation experimental group (2003-2006). Following the implementation of the software, the number of cancelled surgical procedures decreased (120 vs. 12, \( p<0.01 \)). During the same period, the average number of inpatient admissions increased (5725 vs. 6120), and the median emergency department LOS decreased (247 vs. 232, \( p<0.01 \)).

Methods and Materials
We first created an interdisciplinary team of clinicians and hospital administrators including experts in system improvement/process improvement to examine the problems of bed availability and patient flow from admission to discharge. We then developed and implemented a new software application to improve coordination and facilitate communication between disciplines, and to establish an efficient bed management process. We piloted the software among the five inpatient medical teams that cover approximately 50% of all patients admitted to the hospital. We finally tested the effectiveness of the software by comparing the number of cancelled surgical procedures during the pre-intervention control group (winter season 2002-2003, before implementation of the software) to the number of cancelled surgical procedures during the post-intervention experimental group (winter seasons 2003-2004, 2004-2005 and 2005-2006, after implementation of the software). We also compared emergency department (ED) LOS and total number of inpatient admissions between the same two periods.

Setting: This quality improvement pilot project took place at Primary Children’s Medical Center (PCMC), a freestanding academic children’s hospital in Salt Lake City, Utah with strong affiliation with the Department of Pediatrics at the University of Utah, School of Medicine. PCMC had 232 licensed beds, and was owned and operated by Intermountain HealthCare, an integrated health care delivery system serving patients in Utah and portions of five surrounding states.

Needs Assessment: The interdisciplinary team performed a needs assessment to examine and identify: 1) the current patient discharge process including individual responsibilities and 2) the communication methods between these individuals.
The team identified that the ultimate bottleneck for patient flow occurred on the general wards resulting from inefficient discharge of patients to home. Patients who could have been transferred from the pediatric intensive care unit (PICU) or admitted from the operating room (OR) and ED did not have a floor bed. Patients who could have been discharged to home from the general ward were still occupying a hospital bed. The discharge process was unnecessarily delayed and the entire hospital flow was disrupted.

The team recognized that the hospital could increase its effective capacity by making more efficient use of existing bed space and by establishing a daily routine for forecasting and executing discharges. One of the solutions was to develop and implement Patient Tracker, a web-based software application, to improve coordination and communication between disciplines and to establish an efficient discharge process.

**Requirement analysis:** The interdisciplinary team then determined that a standard discharge process must be developed with explicit discharge criteria that could be communicated to all clinicians caring for a specific patient. In addition, the team determined that the distributed electronic software tool should be accessible from anywhere in the hospital to facilitate communication among these individuals.

**Software Design:** The web-based software was developed using an Oracle 9i (Oracle Corporation, San Jose California) database, apache web server software and built on the Java (Sun Microsystems Inc, Santa Clara, CA) architecture. Patient demographics were pulled into the Oracle 9i tables from the legacy electronic medical record database and included name, date of birth, weight, admission date and encounter number. Specific views were created for each of the five medical teams and each of the six medical-surgical units (non-intensive care units). Software design began on October 22, 2003. The first version of the software was available on December 15, 2003 and included the following features:

1. A one-screen summary of critical information for each hospitalized patient (Figure 1). The summary included dialog boxes for the following:
   a. Demographics and ADT information
   b. Assigned attending physician, medical team, intern, and consultant services
   c. Diagnosis, medication list, discipline-specific task lists.

2. Patient specific discharge criteria including current discharge status summary (Figure 2), nurse assessment of discharge status, and physician response to nursing assessment.

![Figure 1. Individual Patient View](image1.png)

![Figure 2. Discharge Summary View](image2.png)

3. Views of the current patient lists for interns, residents, attendings, and consultant services including subspecialists, community-based pediatric practices, social work, discharge planning, and ancillary services.

4. Real-time instantaneous census for each nursing unit including a list of available beds.

5. Visual aids for the nursing supervisor with a daily routine for determining and forecasting hospital bed availability.
Software Implementation and Use: Education of the clinicians on the five medical teams occurred during two 1-hour noon conferences on December 17 and December 19, 2003. The software went live on December 22, 2003 for all 5 medical teams at PCMC and was used as follows:

1. Discharge Criteria List. The intern upon admitting a patient entered an initial diagnosis as well as a list of discharge criteria into the Patient Tracker (Figure 1 – “Discharge Criteria”). The discharge criteria were specific, quantifiable medical conditions that, when met, triggered the discharge of the patient.

2. Daily Communication with the Attending Physician Regarding Discharge Criteria. The house officers worked with the attending physician daily to plan for the discharge of each patient. In addition to the patient’s current condition and plan of care, the physicians discussed the patient’s discharge criteria and updated Patient Tracker if needed.

3. Regular Discharge Assessments by Nurses. Twice a day, (2 a.m. - 6 a.m.; and 2 p.m. - 6 p.m.), each patient care nurse assessed his or her patients against the physician-defined discharge criteria in the Patient Tracker software. The nurse entered his or her assessment into the software as follows: Not Ready for Discharge, Will Probably Meet Discharge Criteria Later Today, Will Probably Meet Discharge Criteria Tomorrow, or Meets Discharge Criteria Now (Figure 1 – “Nurse Assessment”). The nursing assessment was immediately visible to all users of the software, including the assigned medical team. A double mouse click on any “Nursing Division” (Figure 2) allowed the user to drill down to identify specific patients by team and physician.

4. Morning Discharge Rounds. Each morning, from 7:30 a.m. to 8:00 a.m., the medical teams reviewed Patient Tracker and identified the patients who were noted by the nursing staff to “Meet Discharge Criteria Now” (Figure 2 – “NOW”). The team rounded on these patients first and the senior resident of each team entered the physicians’ assessment of the nursing assessment for each patient into Patient Tracker. If the attending physician approved the discharge, the medical team proceeded with the discharge paperwork immediately.

5. Bed Control Meetings. Three times a day, the nursing supervisor and charge nurses met to discuss pending admissions, transfers, and discharges. The “Discharge Status Summary” view in Patient Tracker helped them to identify which beds were likely to become available in the next several hours.

6. Discharge Planning Notes. House-wide care managers used Patient Tracker to identify patients that would require home care arrangements and/or other discharge planning assistance. The care managers entered their notes and task lists into the system (Figure 1 – “Care Manager”), thus updating physicians and nurses on their activities.

7. Ongoing Communication. Throughout the day, physicians, nurses, and consultants used Patient Tracker to update patients’ discharge status and to communicate with each other.

Evaluation of the software: To test the effectiveness of the software, we compared the number of cancelled surgical procedures (primary outcome) between the pre-intervention control group (winter season 2002-2003, before implementation of the software) and the post-intervention experimental groups (winter seasons 2003-2004, 2004-2005 and 2005-2006, after implementation of the software). We also compared ED LOS and the number of inpatient admissions (secondary outcomes) during the same period. Unpaired student t and Fisher's Exact Tests were used to calculate statistical significance between the groups.

Results

Compared to the pre-intervention period, overall the number of cancelled surgical procedures decreased, the median ED LOS decreased and the average number of inpatient admissions increased (Table 1) post-intervention. The number of surgical cancellations by winter season decreased significantly from 120 pre-implementation to remain under 20 over the post-intervention seasons (Figure 3). The number of inpatient admissions by winter season also increased substantially from 5675 patients to 6423 patients over the post-intervention period (Figure 4).

Table 1. Outcomes pre vs. post-implementation

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Pre</th>
<th>Post</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Surgical cancellations</td>
<td>11.5%  (120/1044)</td>
<td>0.4%   (12/3340)</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Median ED LOS (min.)</td>
<td>247</td>
<td>232</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Average Inpatient admissions</td>
<td>5725</td>
<td>6120</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Discussion

The purpose of this study was to describe the developmental process and effects of changes that occurred at our hospital following the implementation of the Patient Tracker software application to solve an important bed management efficiency challenge faced by academic children’s hospitals. Managing patient flow and controlling the discharge process with the software decreased surgical procedure cancellations and ED LOS while the number of inpatient admissions increased. The software system allowed physicians, nurses and care managers to communicate through a single web page using dialog boxes in Patient Tracker. Previously each clinician maintained a separate paper sheet that was not shared. No additional personnel were needed to execute the process.

To maintain a competitive edge, a major focus of hospitals today is to increase bed capacity without the need to build and staff additional beds. Hospitals need strategies to determine and communicate patient’s readiness for discharge, and to improve their ability to track bed availability. Coordination of patient activities is complicated at academic hospitals and requires that efficient communication of various disciplines be in place to minimize delays in admissions, discharges and cancellations of scheduled surgical procedures.

Previous studies have reported that hospital capacity can be increased without the need to build and staff additional beds. More than a decade ago, Clerkin et al. developed a decision support tool to improve hospital bed assignment of patients at the time of hospital admission or during the hospital stay. In 2000, Cohen and Martorella also implemented a bed availability report to provide relevant information about hospital-wide inpatient activity and facilitate patient placement. Recently, Twamoh et al. reported that ED overcrowding is a critical problem nation-wide. To facilitate patient flow out of their ED, they identified the causes of delays in discharges and admissions, instituted the practice of flagging the charts of patients ready for discharge, and implemented admission orders to decrease patient waiting times.

Our study demonstrated the benefit of using health care information technology (HIT) for efficient hospital bed management. Several factors were critical in the success of Patient Tracker and included the following: 1) administrative support for project prioritization and resources allocation, 2) motivated system improvement/process improvement experts leading the team to design and test a discharge process flow before designing and implementing the software application, 3) local control for rapid cycle software application development, 4) the application required very little training because the user interface was simple and intuitive, 5) the application had labor-saving features that made it attractive to physician users such as a sign-out sheet for residents, hospitalists and subspecialists. Therefore, physicians were eager to use it.

One might reasonably suspect that the reduction in surgical cancellations achieved following the implementation of the software was a simple case of fallen demand. In fact, demand did not fall during this period. The improvement was achieved despite the fact that total hospital admissions rose significantly from 5725 to 6120 during the post implementation period. One might also argue that
when hospitals experience inpatient bed shortages, the ED bears the major burden of the problem and patients awaiting admission are forced to remain in the ED for many more hours. However, reduction in the number of cancelled surgical procedures was achieved while the ED LOS during the post-implementation period decreased. This reduction, while small, is statistically significant, and tends to refute the notion that the reduction in cancelled surgical procedures was achieved by delaying admissions from the ED.

Our project plan for the future includes the following items: 1) Roll the software and discharge process out to all physician groups including surgical services to increase utilization to nearly 100% of inpatients. 2) Incorporate Patient Tracker into the existing EMR infrastructure to facilitate access to lab data and clinical notes and to eliminate duplicate documentation. 3) Incorporate alphanumeric paging within the application to further enhance nurse/physician communication and instantaneously notify the medical team whenever nurses identify patients as ready for discharge. 4) Incorporate a discharge check list for critical steps in the final stages of the discharge process. The team anticipates that these enhancements will continue to facilitate efficient use of our limited resources: beds and nursing staff.

Limitations: Our study has some inherent limitations: 1) due to the nature of the evaluation conducted, we cannot necessarily presume a causal relationship between the software application and the outcomes. We did not implement Patient Tracker under controlled laboratory conditions. Rather, the software was introduced into a dynamic real-life hospital situation, in which many other confounding factors may have affected the results. These factors could have been accounted for using a randomized controlled trial. 2) Secondary outcomes used in the evaluation have been used in previous studies of hospital bed management and are indirectly affected by inefficient discharge processes. We believe that, in addition to these outcomes, measuring hospital inpatient LOS would have provided our study with additional information directly related to the hospital discharge process. However, we did not have pre-intervention data identifying patients admitted to a specific medical team for comparison. 3) After achieving significant decrease in the number of cancelled surgical procedures in 2003 following the implementation of the software and with increasing hospital bed demands, the hospital did add six beds to its PICU in 2004. This expansion might have played a role in alleviating further the need to cancel surgical procedures during the latter part of the winter seasons and confounds our ability to gauge the impact that Patient Tracker had on the number of cancellations during that period.

Conclusion

The Patient Tracker software is an interdisciplinary communication tool that has been widely used and effective in coordinating inpatient flow. The use of the software facilitated a decrease in cancellations of surgical procedures and in delays of admissions through the ED. This is an example of the use of HIT to solve an important bed management efficiency challenge faced by academic hospitals.

References

2. Falvo T, Grove L, Stachura R et al. The Opportunity Loss of Boarding Admitted Patients in the ED. Acad Emerg Med. 2007 Mar