Case Study on Using Lean Principles to Improve Turnaround Time and First Case Starts in an Operating Room

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Abstract
Hospital operating rooms are experiencing higher costs and less available capacity, yet they typically generate the highest returns of all hospital departments. In the case study described in this paper, a process improvement team in a hospital Operating Room Department at aimed to address these issues by decreasing the turnaround time between surgical cases and increasing the percentage of first cases of the day beginning at their scheduled time. These two performance metrics were targeted for improvement through the use of lean work system principles implemented by a cross-functional process improvement team of OR employees aided by external consultants. This systematic improvement project resulted in significant improvement in on-time first case starts and slight overall improvement in turnaround time by the time the formal process improvement project concluded. This paper summarizes the overall approach used by the team, key tools applied and associated findings, results for performance metrics, and potential future improvements.

Keywords
Lean, process improvement, operating room, 5S

1. Introduction and Background
Montgomery Regional Hospital, or MRH, is a hospital within the Hospital Corporation of America – Capital Division (HCA), an investment-based healthcare institution. The 60 full-time employees in the MRH Operating Room Department (MRH-OR) handle over 6,500 surgical and endoscopy cases per year across six Operating Rooms and two Endoscopy Rooms. At the time this improvement project began, the MRH-OR operated at approximately 70% capacity. Although operating in an aging facility with limited storage and organizational space, hospital leadership recognized the potential for improvement, particularly the opportunity to increase OR capacity, thus enabling physicians to schedule more surgical cases. In order to realize this longer-term goal, *turnaround time* and *first case start* were targeted for improvement. Because of the cost of OR time,, with some operating rooms reporting costs of $10–30 per minute (Sandberg et al., 2005), improving *turnaround time* and *first case starts* can result in significant savings in addition to creating needed OR capacity.

Turnaround time (TAT) at MRH-OR is defined as "close-to-cut," or the time from a surgeon closing the incision on Patient 1 to the same surgeon placing the cut on Patient 2. Thus, TAT measures the time from close to cut for a given surgeon, independent of operating room. This measure includes several activities, including:

- Recovering Patient 1;
- Cleaning the OR from the procedure for Patient 1;
- Obtaining equipment, instruments and supplies needed for the procedure for Patient 2;
- Waiting for the surgeon to begin preparing Patient 2; and
- Preparing Patient 2 (e.g., positioning, inducing, etc.).

The practitioner and academic literature addresses TAT improvement in a variety of ways. Key areas of change reported include: classification of different types of surgeries ("families" of cases), staffing, inventory and storage, and scheduling (e.g., Sandberg et al., 2005; Sokal et al., 2006).

A first case is defined as the first scheduled case of the day in each operating room before 1:00 p.m. The patient in-room time is defined as the time at which the patient physically enters the room (also referred to as "wheels in"). Thus, the metric *first case start* (FCS) measures the delay of any first cases that have an actual patient in-room time greater than the scheduled start time. Any difference greater than zero counts as a delay (i.e., a patient arrival into an OR at 8:01 for a scheduled surgical procedure at 8:00 a.m. is defined as late).

At the start of the improvement project in August 2008, performance of TAT and FCS were quite stable over at least the previous six months. Goals defined by HCA and MRH leadership were to decrease TAT by about 35% from its current performance and to increase FCS by about 50% from its current performance. Improvements in these metrics were linked to an incentive plan for the MRH-OR, such that employees would receive a financial bonus for significant progress toward these goals. Based on meeting defined levels of improvement for each of these two metrics, OR employees could receive up to 10% of their base pay based on quarterly performance on these metrics. The incentive plan design also required that performance on quality metrics be sustained for any bonus to be awarded. Thus, the incentive plan was designed to prevent the potential trade-off of making improvements to TAT and FCS at the expense of quality.

2. Methods and Results

In order to systematically improve TAT and FCS, a formal process improvement (PI) team was launched in August 2008. The team was comprised of employees representing different functions within the MRH-OR (e.g., Operating Room, Endoscopy, Ambulatory Care Services, and Central Sterile Staff) as well as hospital administration. The team composition also included several research personnel from who served as external consultants and facilitators. Physicians at times attended team meetings to provide input as the team considered specific changes to OR processes. The team's activities presented in this case study occurred from August 2008 through December 2008. During this time, the team met once per week for the most part, with less frequent meetings the last month.

Before beginning the improvement activities, the team created a structured team charter. Research has demonstrated the impact of a well-defined team charter on team performance (meeting goals) and team member satisfaction (e.g., Van Aken, 1995). Through the team charter, the team defined why it exists, who the team members and stakeholders are, what the problems and opportunities are, what the team will accomplish, what resources the team has, what boundaries and constraints the team must operate within, how the team will accomplish the objectives, and how the team will function.

Creating a team charter allowed the team to clarify its outputs and deliverables for the improvement project and define additional expected outcomes other than TAT and FCS (such as creating a culture of continuous improvement, increasing employee capabilities for change, etc.). Due to the complexity of the TAT process, specifically the interdependence of several hospital functional groups, the team decided to focus its efforts on improving TAT for the first stage of the improvement effort and then focus on FCS. Moreover, the team determined that many of the process changes developed for TAT improvement would also directly improve FCS activities, while the converse was not always true.

The team used several process improvement tools in order to define the "target system," analyze the current state, and design the future state. Figure 1 illustrates the tools and techniques used during each phase of the improvement process.

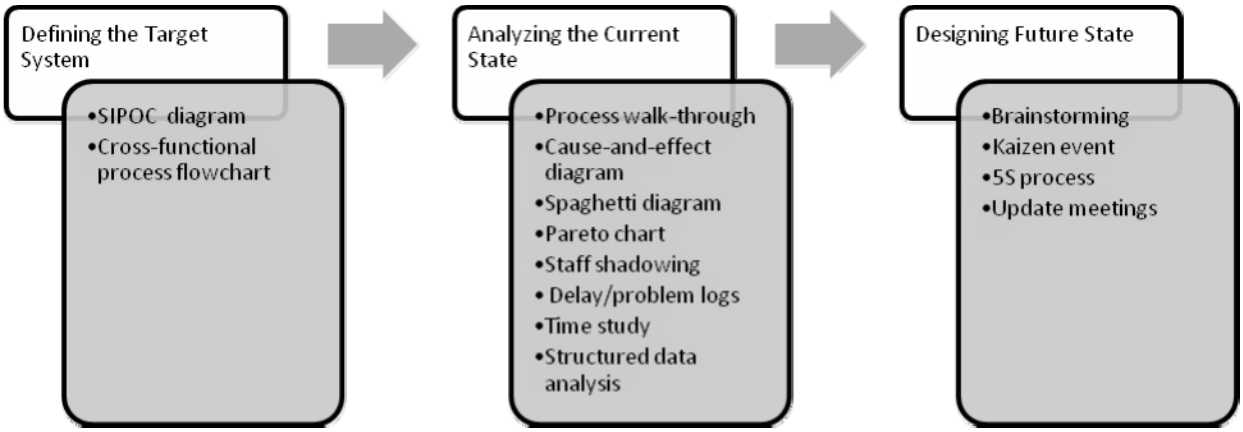

Figure 1: Improvement Process Phases, Tools, and Techniques

2.1 Defining the Target System

To define the target system, a SIPOC diagram and cross-functional process flowchart were created. The SIPOC diagram defines suppliers (including vendors), inputs, processes, outputs, and customers (including stakeholders). The SIPOC diagram also helped to define the boundaries of the "system" being targeted for improvement and clarify what would be in and out of the scope of the team's efforts.

The cross-functional process flowchart was used to define the turnaround process at a more detailed level (i.e., tasks and activities), order of steps, decision points, and the steps that each MRH-OR employee (circulator, scrub nurse, transportation staff, anesthesiologist, and/or surgeon) performed. This tool allowed the team to define the primary process, or the steps that occur in every case, and the secondary process, or the steps that sometimes occur depending on the specific surgical case. The process flowchart can also be used to identify opportunities for reducing the number of steps taken, reduce the number of hand-offs, and utilize more parallel processing to reduce TAT.

2.2 Analyzing the Current State

A number of tools were used to analyze and understand the current turnaround process including a structured process walk-through (with one of the external consultants performing the role of a "mock" patient), cause-and-effect diagram, spaghetti diagram, Pareto chart, staff shadowing, and delay/problem logs. Extensive data analysis of all cases between April and August 2008 was also conducted. Detailed analysis examined TAT data by day of week, by surgeon, by anesthesiologist, by specialty (e.g., general surgery, orthopedic, etc.), and operation name for different segments of the TAT process (e.g., "wheels in" to surgeon arrival). Using a variety of portrayal tools, the data analysis revealed that improvement efforts could be targeted to the top ten surgeons whose cases represented approximately 80% of the surgical and endoscopy cases occurring between this time period, so long as enabling their improvement did not result in corresponding declines in performance of the remaining physicians.

2.3 Designing Future State

The process improvement team conducted a brainstorming session to determine specific solutions to the problems identified through the analysis conducted in the previous stage of the project. Examples of brainstormed solutions related to storage and communication to improve TAT are listed below:

- Storage
  - Create standard list of items to keep in each OR
  - Order items such as rolling carts to organize items better
- Communication to improve patient flow
  - Improve communication between OR Surgical Timing Coordinator and ACS Coordinator
  - Install additional phone lines

The brainstorming session also resulted in solutions that could be used to improve FCS. Examples of solutions which related to scheduling, pre-admission testing and communication improvements are listed below:

- Improve case scheduling to allow for greater preparation for all first cases
- Encourage the use of Pre-admission testing

  - Office directed interventions
- Improve communication with the surgeon (e.g., emphasize the importance of their timely arrival)
- Visit surgeon offices and review information needed from office staff in order to properly prepare patient for surgery
- Additional training of more nurses to improve their IV competencies
- Improve the case picking area and process

A Kaizen event was conducted to focus on improvements related to storage of equipment, instruments, and supplies. A Kaizen event is "a focused and structured improvement project, using a dedicated cross-functional team to improve a targeted work area, with specific goals, in an accelerated timeframe" (Farris, Van Aken, Doolen, and Worley, in press, p.1). The objectives of the Kaizen event were to utilize a 5S approach to eliminate unnecessary items, improve the efficiency of storage space, and improve workflow in the MRH-OR. 5S is a well-known tool within the lean work system portfolio of tools that integrates a focus on workplace organization with the establishment of standard procedures and process discipline needed to sustain changes (Zidel and Hacker, 2006).

These improvements were necessary in order to lay the foundation for other process improvements. The Kaizen event was held in mid-October on a Friday-Saturday to minimize interruption to the OR. The Kaizen event team consisted of members from the full process improvement team, as well as additional OR employees (e.g., supply chain coordinator, orderly, etc.) that would be needed to increase buy-in for changes made. The following changes and outcomes occurred as a result of the Kaizen event:

- Used the 5S process to create and implement a clear visual system of organization of equipment, instruments, and supplies;
- Removed equipment and carts from visible hallway space;
- Reduced total inventory by about $22,000;
- Reduced the physical "foot print" of floor space required in the OR for equipment, instruments, and supplies by 38%;
- Improved accuracy and feasibility of inventory levels;
- Improved layout and flow of case picking area; and
- Created a structured audit process and tool to monitor and sustain the 5S system of organization.

Finally, progress meetings were held at least bi-weekly following the Kaizen event to review progress on follow-up items from the event and on action items that were not addressed specifically during the Kaizen event.

3. Conclusions and Future Work

The fundamental question under consideration is the utility of pay-based incentives as a means to enact positive change in OR performance. Based on early data, the results have been mixed. On the positive side, the participating staff was actively engaged in the improvement process throughout the performance period, which could realistically have resulted from the pay-based incentive. However, some of the intermediate data collected by the team indicates that this incentive had little or no impact on the performance of the OR.

Specifically, the first two weeks of the incentive plan period (October 1, 2008-October 14, 2008) occurred before the 5S Kaizen event, and before several other targeted improvements. During this time period, FCS and TAT metrics were unchanged from their baseline levels. While a brief time period, this lack of change suggests that the pay-based incentive alone was not sufficient by itself to enact positive change. The OR system was likely functioning at its highest possible level of efficiency prior to the incentive plan being introduced, but tangible improvement was prevented by general, systemic inefficiencies. Without addressing these systemic inefficiencies, the incentive program would likely have not created desired outcomes.

With the systemic improvements in place for the first quarter of the incentive plan (October 1, 2008-December 31, 2008), FCS improved about 25% during this quarter compared to baseline performance levels. This improvement can be attributed to the solutions implemented by the improvement team, particularly improving case scheduling and facility layout. Overall, marginal improvements have been observed in TAT, with an overall reduction of about 5% during the same quarter compared to baseline performance levels. However, significant improvements in TAT have been made by specific surgeons and the nursing teams who typically work with them. Although only anecdotally

observed, these more successful surgeons and teams have displayed a greater sense of commitment to improving their TAT as compared with other surgeons. Currently, the improvement team is working to further study the activities of these surgeons and their teams and present them as models to the rest of the OR. Furthermore, anecdotal feedback has indicated that seasonal staffing challenges during Q4 2008 contributed to higher TAT, and as such even the small improvements observed in November and December were surprising. More consistent data is anticipated in Q1 2009, which will enable clearer understanding of the improvement project's impact on the system.

In the future, the MRH-OR also plans to continue its improvement efforts by obtaining more support and involvement from surgeons and anesthesiologists. Future work could also involve the implementation of additional TAT and FCS improvement methods described in the relevant literature. For example, in a study using statistical and mathematical models to decrease turnaround time through the application of parallel processing, the solution of conducting induction and room turnaround concurrently was implemented with success (Sokal et al., 2006). Other similar examples may help MRH-OR to obtain their goals related to TAT and FCS as well as the longer-term goal of increasing the number of surgeries.

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