Maximizing Operating Room Turnover Efficiency via Process Mapping and Critical Path Modeling

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Abstract

Process Mapping was applied to identify opportunities for reducing OR turnover times at Gundersen-Lutheran Hospital Systems in Wisconsin. Key analytics and metrics were identified through this process analysis. Critical Path Modeling was applied next. Simultaneities were identified and elucidated. Lastly, greater efficiencies were realized by shortening activities along the CP.

Keywords: Process mapping, operating room, CPM

Introduction

Operating room (OR) turnover between surgical cases involves a multitude of variables and individuals that renders tackling the subject quite complex and multifaceted. Creating OR turnover efficiencies is extremely important as OR turnover impacts a number of performance metrics and analytics. For surgeons the time spent transitioning from one case to the next is considered wasted and non-productive and is often the cause of surgeon's dissatisfaction and complaints. For patients the time spent waiting for their surgery is often stressful, and nerve-racking during which they could be in pain or in serious morbidity. For hospitals' administration OR turnover is non-value-added and non-productive since the time spent transitioning OR is most often not reimbursed nor allocated on a shared cost basis which negatively affects return on investment (ROI) and overall productivity. In an era of decreasing reimbursement and the resultant non-escalating pressures to improve efficiency throughout, hospital OR administrators are oftentimes lackadaisical in their effort to improve OR turnover.

This paper presents the initial results of an exploratory study conducted jointly by a medical surgeon and an OM professor/logistician granted unique access to real OR set-up times and primary data collection in a hospital system in the U.S. Midwest. Process mapping was applied to identify opportunities for reducing OR turnover times at Gundersen-Lutheran Hospital Systems in Wisconsin. Key analytics and process time metrics were identified and analyzed throughout this process analysis. The authors applied Critical Path Analysis in an effort to identify simultaneities and reduce overall

path time. This paper presents the initial process mapping results primarily. For complete results including the critical path modeling, please contact the lead author at the above e-mail address.

Turnover Time Definition

It is necessary to clearly and accurately define turnover time since the term has been used to describe different durations in the process. It is the simplest definition and data could be easily collected from the computerized OR records. Others have defined turnover time as the time needed to set up and clean up for the same procedure excluding gaps and delays (Mathias, 2000), or the length of time it takes for a patient to leave the operating room on one case to the incision made on the patient of the following case (Scott & White, 2005), or the sum of set-up time and room clean up time plus delay time for the same case (Mowbray, 2003). For Adams, overall turnaround time starts when a surgeon leaves the OR after completing a case and ends when the surgeon arrives in the OR for the following case (Adams, 2004). This lack of consistency only adds to the controversy of turnover time studies. We adopt Dexter's (2003) definition for its simplicity and robustness. In this paper OR turnover time refers to the length of time that starts when one patient leaves the OR and ends when the next patient on the schedule enters the OR (Dexter, 2003).

Methods

To study and improve OR turnover process and time at Gundersen Lutheran hospital the pilot study focused solely on orthopedic (i.e., ortho) surgical cases and OR turnover to decrease variability related to type of cases, surgeons and staff involved. The OR turnover improvement team was composed of the team leader, an MBA student who was also an anesthesiologist, the Administrative Director of OR, the OR manager, a quality improvement specialist and two OR nurses.

Using ORSOS database baseline OR turnover time was calculated. Data collection started after a modification in the scheduling of cases took effect and lasted for four weeks. Ortho cases were included only and any emergency cases and all cases on weekends were excluded. The turnover process was then observed thoroughly while various cases were transitioning. Several nurses and technicians were interviewed to clarify certain steps and tasks. A process map was constructed outlining all tasks in the process. The team met and discussed the process frequently during the study period. Because of the complexity of the tasks involved additional analysis was needed to evaluate the duration of important tasks and to specify the tasks in need of change. Benchmarking was not sufficient or specific enough to recommend changes. Root causes of delay could not be objectively documented from ORSOS since it does not supply the required detailed time input when tasks start and end. Interviews with OR nurses was found not to be completely objective since it was influenced by past experience and opinion. For instance one OR nurse blamed all delay on anesthesia staff without hesitation.

In order to address this shortcoming or constraint, an independent observer was added to the research team. We then collected additional data in a survey of turnover

time usage. The survey was completed by independent observers who were intimately familiar with the OR settings but not part of the staff assigned to the OR. The richer data collected include the presence of additional floater nurses in the OR and the times when: the surgeon leaves the OR table, the nurse makes an overhead call for cart and orderly the orderly starts cleaning the circulating nurse is back in the OR the scrub nurse is back in OR, cleaning is complete and orderly leaves the room, the circulating nurse calls preop to send for next patient, the anesthesia staff starts putting the patient under anesthesia, and when the surgeon was in the room The survey was completed for 50 turnover cases and the data was used in conjunction with the data from ORSOS to calculate the time interval of each task.

After time interval calculation of tasks was performed and best practices in the field reviewed, recommendations for improvement were formulated. Implementation of improvement was limited to a couple changes because of the time limitation with a resultant new turnover time.

Table 1 Results

	Pt-out to Pt-in	**Pt-in to incision**	**Pt-out to incision**
Mean (minutes)	**38**	**38**	**76**
Median(minutes)	**34**	**36**	**71**
Range(minutes)	**15 - 119**	**12 - 118**	**34 - 164**

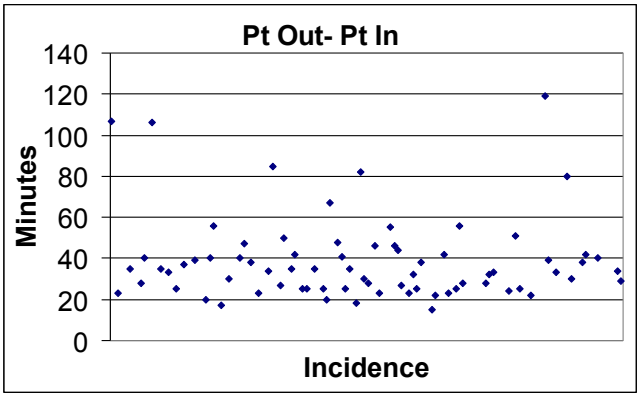


Figure 1 : Scatter diagram of patient-out to patient-in time interval

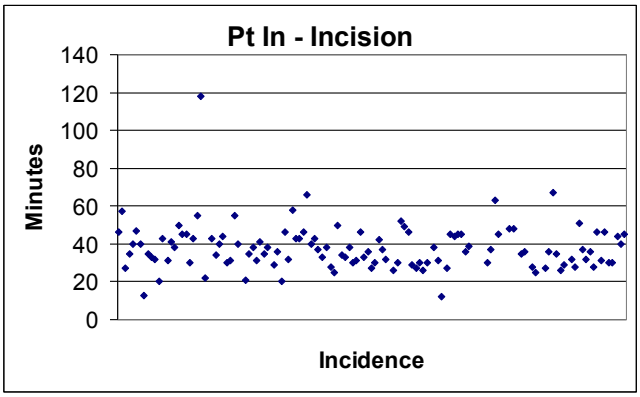


Figure 2: Scatter diagram of patient-in to incision time interval

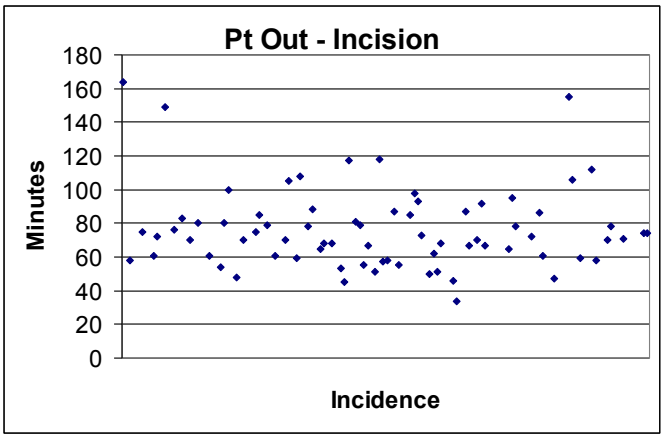


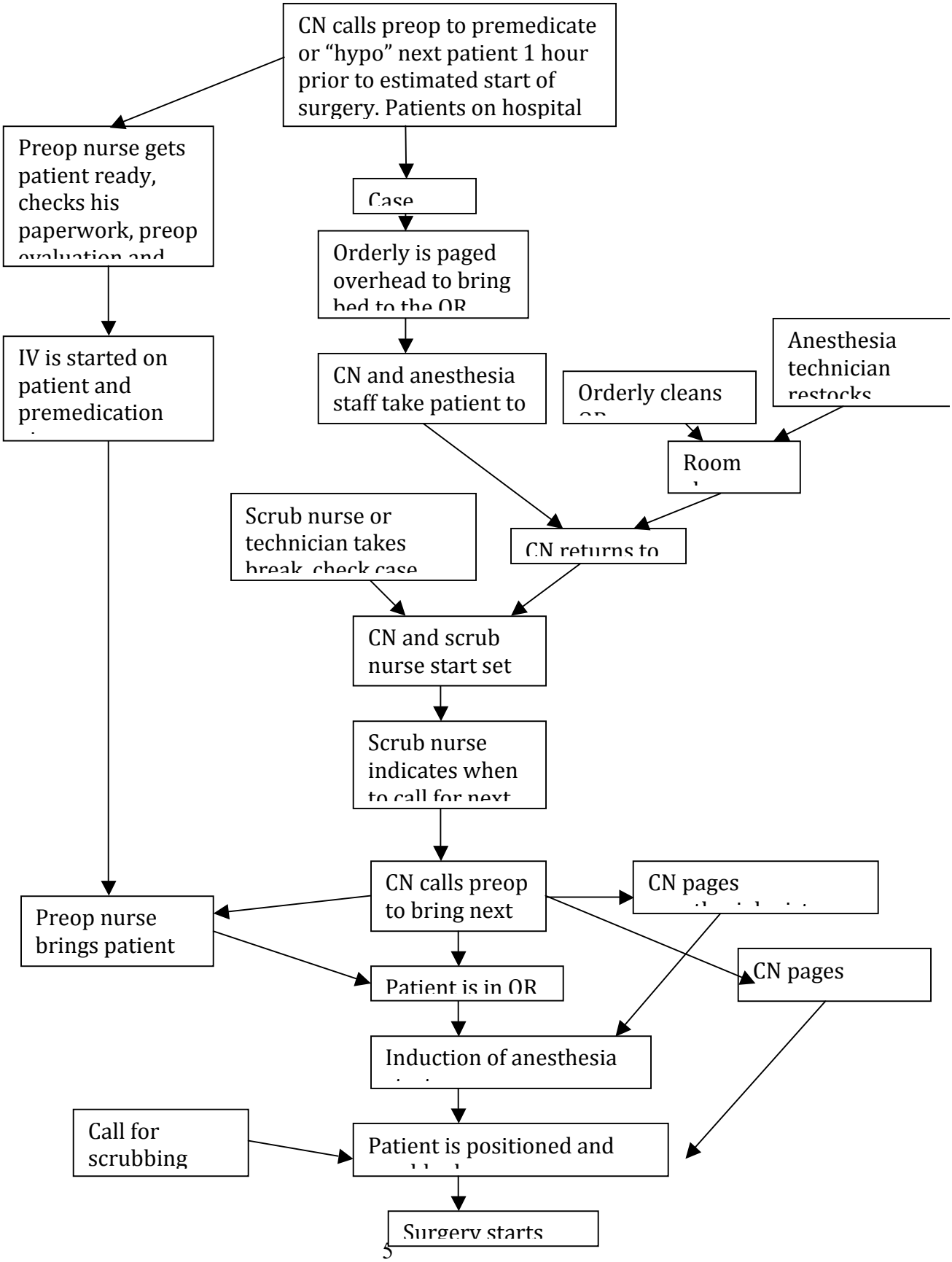
Figure 3Figure: Scatter diagram of patient-out to incision time interval

Discussion

Baseline turnover time for Ortho cases averaged 38 minutes with a median of 34 minutes when data from 89 turnover cases was collected. The interval from when the patient is in the OR to incision was 38 minutes on average with a median of 36 minutes and the interval from when the patient is out to the incision for the next patient is 76 minutes with a median of 71 minutes. Scatter diagram also illustrate these findings in figures 2, 3 and 4.

The process map for OR turnover is illustrated in the diagram in figure 5.

- Figure 4 Turnover



The process starts when the circulating nurse calls preop to premedicate next patient usually 1 hour prior to estimated start of surgery. Patients on hospital floors are called 1.5 hour prior to start. In the holding area the preop nurse then gets patient ready, checks the paperwork, pages the anesthesia staff to complete the preop evaluation. An IV is started on the patient and premedication is given. The patient then waits for the next call from the OR. During the same time the case ends in the OR and the orderly is paged overhead to bring in the bed. The circulating nurse and the anesthesia staff take the patient to PACU. Meanwhile the orderly cleans the OR and the anesthesia technician restocks the anesthesia machine and cart. The scrub nurse or technician and the circulating nurse return to the OR and start setting up for the next case. When the scrub nurse is ready the circulating nurse calls preop to send the next patient and pages the anesthesiologist, surgeon and physician assistant or resident. Every time the circulating nurse pages someone she or he has to answer the phone and inform the caller of the reason of the paging. The preop nurse brings the patient to the OR and as soon as the anesthesiologist is ready induction of anesthesia starts. The patient is then positioned and scrubbed with the help of additional assistants who sometimes have to be paged before surgery start.

When the results of the survey were combined with the OR computerized data the most important time interval were calculated (Table 2).

	Range	**Mean**	**Standard Deviation**	**Median**
Cleaning Time	4 – 28	11	4	11
Circulating nurse absence from the OR	0 -21	8	4	8
Scrub nurse absence	0 – 60	12	7	11
Room Setup till sending	0 - 33	10	7	8
Patient Delay in Preop	2 - 65	9	9	8
Set up	5 - 66	19	10	18
Waiting for Induction of Anesthesia	0 – 20	7	3	7
Anesthesia start to arrival of surgeon	0 - 21	8		
Anesthesia start to incision	3 - 63	29	12	26
Surgeon out to patient out	5 - 44	19	8	18
Turnover Time:				
Floaters helping	17 – 47	27	8	25

No Floaters	16 – 50	33	9	32
One Floater	17 – 38	24	5	22
More than one floater	20 - 47	29	8	25
Baseline Turnover	15 - 119	38	19	34
Turnover with data collection	16 - 75	30	11	27

Table 2: Time interval from survey of turnover

Analysis and Discussion

The median turnover time was 26 minutes for orthopedics surgery when data was collected over 2 years from 42 hospitals and 24 ambulatory surgery centers by a management consulting firm (Patterson, 1999). By comparing this finding to our baseline turnover time of 38 minutes on average or 34 minute as median there is plenty of room for improvement. The survey of turnover time usage helped markedly in breaking down the turnover time into smaller chunks that can be addressed individually. The cleaning time average of 11 minutes is not excessive since benchmark cleaning time averages ranging from 10 minutes to 15 minutes for different ortho cases have been reported (Mathias, 2000). The delay of orderlies varied between zero and 6 minutes depending on how you define it. If it starts when the circulating nurse pages overhead then it is 6 minutes on average. But the paging occurs when the patient is still in the room, so cleaning can be done minimally. In 24 out of 52 cases the orderly started cleaning before the patient left the room. In the rest of cases cleaning started as soon as the patient left or 2 to 3 minutes later. This result could have been influenced by the presence of the person collecting data.

The time spent by the circulating nurse transporting the patient averaged 8 minutes. This is attributed to the responsibility of the circulating nurse to transport the patient after surgery. This result was probably influenced by the presence of the person collecting data and in reality is probably greater than what was measured. This time spent outside the OR lengthen the turnover of the room and is not value creating. If in the room the circulating nurse will expedite cleanup and setup improving efficiency. Liberating the circulating nurse from transport duty is a practice used by anyone improving their turnover process. The occasional long absence of the scrub nurse from the OR (average 12 minutes) could indicate the lack of scheduled breaks that was substantiated by the staff. This can be easily remediated by scheduling breaks where a substitute scrub nurse fulfills the duties of the scrub nurse on break.

The time spent setting up the room has two components. After cleaning is complete set up starts, then the circulating nurse sends for the patient while setup continues. The duration of the setup averaged 19 minutes. This time can be minimized since setup can run in parallel to other preparations. The patient could come to the OR and induction of anesthesia proceeds while setup is ongoing. These tasks could very easily run in parallel rather than in series improving turnover time markedly.

Instruments cleaning task could be improved too since it also affect duration of setup.

Patient delay in preop was 9 minutes on average from the time the circulating nurse sends for the patient until the patient enters the OR. There is probably room for improvement but this time can be factored in the sequence of tasks. It took the anesthesiologist an average of 7 minutes to start induction ranging from 0 to 20 minutes. This time can be minimized by few improvements. For example, with an improved and simplified communication system the anesthesiologist, CRNA or technician could bring the patient to the OR and start induction rather than wait for the patient to come in. Blood pressure cuff and ECG pads could be placed in preop in addition to the lines and blocks that are now placed in preop. The duration from anesthesia start to arrival of surgeon could also be decreased from the average of 8 minutes (range: 0 – 21) with a better communication system in place. With the current paging system communication occurs after at least three tasks taking place. The nurse has to page the surgeon or assistant who have to call the OR. Then the nurse has to interrupt her work to answer the phone and transmit the information. The current system is time consuming and delays the circulating nurse especially if several persons have to be paged, in the process of setting up. The time spent between start of anesthesia until incision was 29 minutes on average (range: 3 – 63). It reflects the induction time as well as prepping and positioning. Improvement is possible with enhanced coordination of the whole team. The time elapsed from when the surgeon leaves the OR table until the patient is out was 19 minutes on average ranging from 5 to 44 minutes. This time creates the perception of surgeons that turnover time is unreasonably long. By participating further at the conclusion of surgery surgeons could help expedite that time and minimize their non-value time.

The presence of floaters assisting with turnover affected significantly turnover time. It decreased from 33 minutes when no floaters where helping to 27 minutes when they were. The difference was statistically significantly with a p-value of 0.02. This indicates the importance of having assistance from floaters during turnover. When comparing the effect of one floater to that of 2 or 3 the result was surprising but not totally. Turnover time was 24 minutes with the presence of one floater but 29 minutes with the presence of 2 or 3. This observation is important since more floaters in the room do not necessarily improve turnover time but rather increase disorder in the process. The cost benefit would be lost and efficiency decreased. The effect of having a person collecting data in the OR is clearly visible with the noted decrease in turnover time during data collection. We note a baseline of 38 minutes turnover time decreased to 30 minutes during data collection. The difference is statistically significant and can be attributed to the awareness of OR personnel of being observed. The behavior of orderlies, nurses, anesthesiologists and surgeons could have varied during data collection. The approximate 20% change could be added to the values found to compensate for the artificial improvement.

We next reviewed best practices in a number of arenas and coupled those with potential improvements we identified during observation. Those included scheduling (Mathias, 2000); standardization of instruments (Health Care Advisory Board, 2000; Mathias, 2000); front-loaded anesthesia prep and early patient entry; communications (Tarantino, 2004); Consistent and timely notification to surgeon of room readiness

improves turnover (Adams, 2004); and, liberating a circulating nurse. To name but a few. For a complete list of and for our CPM, please contact the lead author at the e-mail address provided.

Recommendations

From the data analysis and review of best practices along with our process mapping the following changes and improvements are recommended to significantly decrease turnover time at this center: a) Liberate the circulating nurse from transporting patients in order to dedicate the time to cleanup and setup; b) Delegate the responsibility of transporting patients to other personnel such as orderlies which would then necessitate the hiring of additional orderlies; c) Create a better communication system with orderlies such as two-way radios or talking beepers; d) Coordinate a substitute during scrub nurses' breaks; e) Bring patient into OR as soon as the room is cleaned prior to completion of setup. This allows anesthesia care and room setup to occur in parallel; f) To coordinate patient's prep and positioning use a communication system better than overhead paging; g) Delegate one floater to each OR to assist with turnover. More than one floater appears counterproductive; h) Involve surgeons and anesthesiologists further with the strive for improvement and get enhanced collaboration; i) Delegate certain tasks to anesthesiologists if agreeable such as transporting patient from preop to OR, and modify some practices such as putting blood pressure cuff and ECG pads in Preop; j) Share the responsibility of the time from when the surgeon leaves the OR table to when the patient leaves the OR with the surgeon; and, k) Follow up on the turnover study and collect data every 6 or 12 months to detect possible room for improvement.

Conclusion

After studying thoroughly the turnover process in the orthopedic operating rooms at Gundersen Lutheran it was clear that the process could be improved resulting in a shorter turnover time. Following the documentation of the duration of tasks with data collection and after reviewing best practices several recommendations for improvement were formulated. Critical Path Analysis was performed next, but space limitations constrain the presentation of results. The combinations of several essential changes will surely result in significant shortening in turnover time. We noted significant decrease in turnover time occurred when an independent observer was present in the OR collecting data. This finding raises the question of the importance of supervision in such a complex process where many teams are involved and efficiency is at stake.

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