Southern California CSU DNP Consortium

California State University, Fullerton
California State University, Long Beach
California State University, Los Angeles

IMPROVING OPERATING ROOM EFFICIENCY: A QUALITY IMPROVEMENT PROJECT

A DOCTORAL PROJECT

Submitted in Partial Fulfillment of the Requirements

For the degree of

DOCTOR OF NURSING PRACTICE

By

Joseph R. Tadeo

Doctoral Project Committee Approval:

Stephanie Vaughn, PhD, RN, Project Chair
Penny Weismuller, DrPH, RN, Committee Member

May 2015

ABSTRACT

Surgical departments in healthcare organizations are costly. The economic viability of the hospital demands that operating rooms (OR) run efficiently. Leading causes of inefficiency are delays with first case starts (FCS) and unknown turnover time. The purpose of this quality improvement project was to improve OR efficiency by increasing compliance with FCS and establishing a baseline TOT for each surgical service. Methods included evaluating FCS before and after the implementation of a preoperative huddle 15 minutes prior to the first surgical case start time for all elective surgical procedures. Turnover time, the time needed to clean an OR after a surgical procedure, was also evaluated. Nurses completed a log identifying the reason for delays in FCSs. Environmental Services staff completed a log indicating start and end time for cleaning each OR. The results of the data were analyzed weekly and prominently displayed in the OR. During the 15-week study period, a huddle occurred for 82.9% of cases, almost 55% of cases started on-time, and delays with FCS decreased by 34%. The absence of the surgeon during the pre-operative huddle increased the delay in FCS five-fold (OR 5.663, 95% CI [3.051-10.510]). Delays to FCS cost $118, 344.52 with $90,755.00 attributed to surgeons. During this project, nursing leadership detected inefficiencies and delays to FCS by clearly identifying the reasons for delays. Inter-professional huddles that included the surgeon decreased surgical delays, promoted teamwork, and increased accountability with starting surgeries on-time.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGMENTS

I would like to express my gratitude to RLANRC's Executive Council and the entire operating room staff because I would not have finished this project without their support. They allowed me to fulfill my passion for program planning and quality improvement. Their willingness to accept a new process that challenged the status quo is a testament to their dedication to improving their practice and patient care.

Most importantly, I would like to express my deepest and most heart-felt appreciation to my family for their unconditional love, inspiration, and encouragement that fueled my drive to pursue a Doctor of Nursing Practice. To my parents, Orlando and Myrna, thank you for instilling the value of education. You have always said that the one thing that no one can take away from you is your education. To my siblings, Lilly, Nanette, Orlando Jr., and Arthur, thank you for inserting levity when things became too serious which allowed me to refocus my energies towards achieving this educational milestone.

BACKGROUND

Problem Statement

In a November e-mail from the Chief Executive Officer (CEO) at a Southern California county hospital (SCCH), the Chief Medical Officer (CMO) for the County Department of Health Services (DHS) informed physician representatives from each hospital within the DHS system that they had been appointed to serve on a Peri-operative Operations Committee on September 9, 2013. These physicians were appointed by the Executive Leadership from their hospitals. According to the DHS CMO, the primary goal of this committee was to improve the timely access to essential, but not emergent surgery, and other non-invasive procedures. The committee was charged with establishing processes for better coordination of surgical services and resources across the system. Additionally, the committee was charged with developing mutually agreed upon and shared principles for peri-operative care delivery across DHS that respects the needs of each facility (J. Orozco, personal communication, November 16, 2013).

In order to support the goal of the DHS Peri-operative Operations Committee, the CEO at the SCCH made improving operating room (OR) utilization a priority for the hospital. The CEO emphasized the importance of increasing OR utilization, while also improving the efficiency, with surgical services in terms of increasing first case starts at the scheduled times, documenting the cause for delays to surgeries, and decreasing turnover time between cases. The OR utilization rate in 2012 was 33%, indicating that there was capacity to decompress the backlog of surgeries from the other DHS hospitals by sending surgical candidates to this SCCH. According to the Chief Operating Officer at the SCCH, this OR utilization rate was calculated based on the actual OR time used for surgeries divided by the possible OR time per 40 hour work week per year. For instance, if the OR was only used 686 hours for the year and the possible OR time for that year was 2080 hours, then the OR utilization was 33%. In 2012, the overall staffing in the ORs limited the number of OR suites that were occupied. The SCCH has the capacity to run five OR suites, but given the lack of staff, they currently only run an average of 3½ OR suites with a maximum of four. The lack of efficient OR utilization impaired the ability to care for surgical patients within the DHS system, which impacted patient satisfaction. This also contributed to staff downtime that increased the cost of providing OR services (J. Orozco, personal communication, September 26, 2013). According to the Chief Financial Officer at the SCCH, the total cost of OR operations for 2012-2013 were $10, 500, 420 at a cost per minute rate of $51.86. This took all staff salaries, equipment, and supplies into account (R. Bayus, personal communication, March 31, 2014).

The Affordable Care Act has changed the landscape of healthcare. The power has shifted to consumers who have the ability to choose their healthcare providers. This is changing the manner in which DHS conducts business as they now have to compete for their share of patients. The emphasis on improving OR utilization and efficiency required the surgical staff to change their practice. The need to coordinate surgical services was paramount because it not only provided better services to the patients, but it decreased the wait time from the receipt of the elective surgical referral to surgery and increasing patient satisfaction. Although these were elective surgeries, the patient’s condition continued to decline as they waited for their surgery.

Purpose Statement

The purpose of my Doctor of Nursing Practice Project was to improve OR efficiency at the SCCH with the sub aims of increasing compliance with first case starts (FCS) as scheduled and establishing a baseline average of OR suite turnover time (TOT) for each surgical service.

Supporting Framework

The Plan-Do-Study-Act (PDSA) cycle is an effective strategy for quality improvement (QI). According to the Deming Institute, the "PDSA cycle is a systematic series of steps for gaining valuable learning and knowledge for the continual improvement of a product or process" ("The PDSA Cycle," n.d., para.1). Using this framework, a quality improvement team was developed and they were charged with planning and executing a project to improve patient care. According to the Institute for Healthcare Improvement ("Science of Improvement," n.d.), the PDSA cycle (see Figure 1) addresses three critical elements: (a) what are we trying to accomplish?, (b) how will we know if a change is an improvement?, and (c) what changes can we make that will result in an improvement?

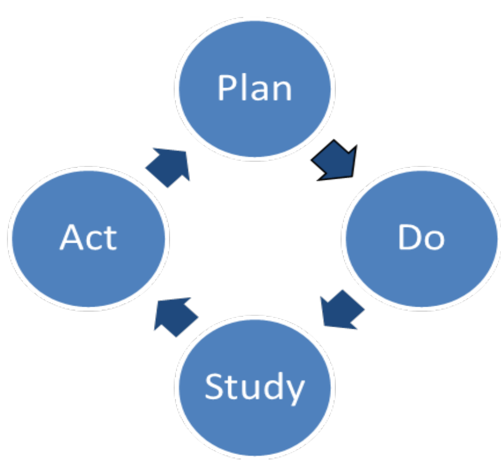


Figure 1. Effective elements in the PDSA cycle.

The PDSA cycle is simple and can achieve impressive results by changing complex systems via small scale trials of quality improvement efforts. There is no need for large scale, randomized clinical trials to gain significant systems and process improvement as it would simply slow down the achievement of outcomes (Berwick, 1998). In a quality improvement project, it is important to have measurable objectives that include a time element to ensure that change occurs. Once the three critical elements above are addressed, the Plan is developed. Goals and objectives are generated to provide a direction towards quality improvement and determine if key metrics are being achieved. Next is the Do step, which implements the test of change, identifies any barriers to achieving the goals and objectives, and initiates the collection of data to determine if change is being realized. This is followed by the Study step, which involves data analysis to determine whether the test of change has resulted in quality improvement. If the data indicate progress towards achieving the goals and objectives, then the process continues. If the data indicates that positive change is not evident, then the process must be evaluated for learning opportunities and another approach to achieve the goals and objectives is warranted. The team's evaluation of the data will determine whether they will Act to proceed towards implementation to a larger scale or revise their approach ("Science of Improvement," n.d.).

Quality Improvement Team

The Administrative team charged with improving OR efficiency and utilization consisted of the CEO, Chief Quality Improvement Officer, the physician champion for the Medical/Surgical System of Care, Nurse Manager for the Medical/Surgical System of Care (Project Leader), and the Interim Chief Clinical Officer. The OR workgroup was comprised of a surgeon, an anesthesiologist, an OR nurse, the Environmental Services (EVS) Director and the Project Leader. The variation in practice led to waste and it was the leadership that had the authority to redesign the manner in which work was carried out to improve quality (Best & Neuhauser, 2005).

What Were We Trying to Accomplish?

Two leading causes of inefficiency in the OR that the team addressed were delays to FCS and OR suite TOT, which was the length of time for cleaning the OR suite to ensure patient and staff safety. The surgeon's presence in the pre-operative area was critical because it triggered a domino effect to expedite the patient's progress from the pre-operative area to the OR suite. Another cause of inefficiency was the lack of an objective awareness by the surgical staff and EVS with regard to the average amount of time that was needed to clean an OR suite after a procedure by the different surgical services. The quality improvement team addressed the goal of improving OR efficiency by increasing FCS at the scheduled time and established a baseline for the average length of time needed for TOT by the different surgical services.

How Will We Know if a Change Was an Improvement?

The process measures to address FCS included (a) determining the process for documenting on-time starts, (b) determining the delays to FCS, and (c) mitigating the delays to FCS. The process objectives for TOT included (a) documenting the start and end times with cleaning an OR suite after each procedure and (b) audits by EVS supervision to ensure that the OR suites were cleaned according to established policies and procedures. The outcome measures for FCS included decreasing delays with FCS and minimizing overtime costs. A surgery that was delayed led to delays with the start of subsequent cases for that particular OR suite and staff worked beyond their regular work schedule. This was particularly true for nursing, anesthesia, and scrub technicians. The outcome measure for TOT included establishing a baseline average for TOT by surgical service.

What Changes Were Made That Resulted in an Improvement?

In order to improve FCS, a pre-operative huddle at least 15 minutes before the scheduled start time was established. This ensured that the domino effect initiated by the surgeon led to expediting the start of the surgical case as scheduled. Nursing documented any delays with FCS. These delays were either staff driven or patient driven. Staff driven delays included late surgeon arrival, incomplete informed consent forms, incomplete history and physicals, as well as pending labs or diagnostics required before surgery. Patient driven delays included presenting to the pre-operative suite later than instructed by the OR staff or their condition was not conducive to surgery such as the presence of fever, rash, or high blood sugar. Nursing documented the actual time that the patient arrived in the OR suite. TOT improvement required EVS staff to maintain a log of time in and out of the OR suite for cleaning after a surgical procedure was completed as well as random audits by EVS supervision to ensure adherence to policies and procedures related to the cleaning of OR suites. The TOT log was kept with the EVS staff. Once the log was completed, it was submitted to the EVS Director and the data were entered into an Excel spread sheet.

PDSA Cycle

The plan as described above was communicated to the OR staff by the Project Leader to ensure that everyone understood the goal of improving OR efficiency with sub aims of increasing FCS at the scheduled time and establishing a baseline average of OR suite TOT for each surgical service. The staff expectations and the rationale with the QI project was clearly communicated to the OR staff as well as the Department of Surgery Committee.

Once the plan was implemented (Do), data analysis was initiated. Did surgeons report for a pre-operative huddle at least 15 minutes before the scheduled start time? Did nurses document delays to the scheduled start time? Did nurses document the time the patient arrived in the OR suite? Did EVS staff log the time in and time out with the cleaning of an OR suite after a procedure? Did EVS supervisors monitor their staff to ensure that the OR suite was cleaned properly? What were the barriers to achieving the overall goals of the project? Were there any unexpected circumstances that presented themselves requiring the quality improvement team to make corrections to the current course that was being undertaken? In this phase, data that was collected was strategically displayed in the OR so that all OR staff witnessed the progress towards achieving the project's goals.

In the Study phase, all data that was collected from the Do phase was analyzed. What percentage of surgeons arrived for the pre-operative huddle at least 15 minutes before the scheduled start time? What percentage of surgical cases actually started on-time? With respect to the OR delays to start time, were they staff driven or patient driven? If they were staff driven, what was done to minimize their impact in the future? What was the average TOT by the different surgical services?

In the Act phase, the QI team analyzed the data to determine whether to continue with the current process or make any revisions and try another route to achieving the project's goals. Even though the QI team decided to maintain their course, they were charged with identifying any modifications that were warranted to continue their progress towards the goals.

Project goal one. At least 50% of surgical cases scheduled first at a SCCH entered the OR suite(s) at the scheduled time.

Staff to be impacted. The staff that was impacted by Goal One were the surgeons, OR nurses, anesthesiologists, surgery technicians, and Information Systems (IS) staff. The key drivers for this goal included (a) respect for the patient's time, (b) support from Executive Council (EC) to drive the proposed changes, (c) buy-in from the OR staff, specifically surgeons, to start cases at the scheduled time, (d) understand the causes for surgical delays, and (e) understand the cost to operate an OR suite by surgical service.

Outcome and process measures. The two outcomes that were measured with this project were increased OR efficiency and decreased delays with first case starts. The process measures that addressed first case starts included the:

- establishment of an OR workgroup that consisted of a surgeon, an anesthesiologist, an OR nurse, an EVS staff member, and the Project Leader;
- review of the OR documentation system used by the OR staff was conducted to determine the sections that housed information related to the start time of cases;

- identification of the reasons for delays to FCS by the Surgical Start Time Log (See Appendix A);
- documentation of the reasons for delays to FCS by the OR nurses at least 50% of the time;
- determination of the frequency of delays to FCS by surgical service on a weekly throughout the project; and
- occurrence of a pre-operative huddle at least 15 minutes before the scheduled FCS time with the surgeon present at least 50% of the time.

Project goal two. A baseline average OR suite TOT was established for each surgical service.

Staff to be impacted. The staff that was impacted by Goal Two were the custodians, surgeons, OR nurses, anesthesiologists, and surgery technicians. The key drivers for this goal included (a) support from the hospital's Executive Council to drive the proposed changes, (b) buy-in from EVS staff to be thorough with cleaning the OR suites between cases, (c) understand the causes of delays with TOT, and (d) understand the documentation by EVS related to time with cleaning the OR suites.

Outcome and process measures. The two outcomes that were measured with this project were increased OR efficiency and decreased delays with first case starts. The process measures that addressed turnover time included the:

- utilization of a log to document the amount of time with cleaning between surgical cases;
- documentation of TOT for each surgical service by the EVS staff; and
- observation of at least one OR suite a week that was cleaned between surgical cases by the EVS supervisor(s).

REVIEW OF LITERATURE

Overview

OR utilization is closely tied to OR efficiency. An efficiently run OR require that each surgical suite is cleaned immediately after a procedure to allow for the acceptance of the next patient thus maximizing the number of cases per day. The databases of ABI/INFORM Complete (ProQuest), CINAHL Plus with Full-Text (EBSCO), and PubMed (NLM) were used in the search for articles. The search terms that were used included operating room, utilization, efficiency, turnover, changeover. Boolean phrases of operat*, util*, and efficien* were used. In all, six articles related to OR utilization, eight articles for OR efficiency, and two articles for TOT were selected for the review of literature. Quantitative and Qualitative articles were reviewed to support the DNP Project. A table of evidence (see Appendix B) provides a detailed list of the key research articles that discussed OR utilization, OR efficiency, and TOT.

Operating Room Utilization

The surgical service is an expensive department to operate (Does, Vermaat, Verver, Bisgaard, & Van Den Heuvel, 2009; Guerriero & Guido, 2011; Peters & Dean, 2011). Therefore, it is essential that the OR utilization rate remains high without the need to increase resources to do so. OR utilization is impacted by the surgery schedule, TOT, and starting cases on-time (Li, Wang, & Powers, 2013). The number of cases on the surgery schedule, or lack thereof, along with prolonged TOT and delays to the start time of cases decrease OR utilization.

The OR schedule plays an integral role with respect to OR utilization. In a structured literature review of operational approaches to OR management, Guerriero and

Guido (2011) found evidence of three types of scheduling: (a) open, (b) block, and (c) modified block. In an open schedule, the surgeon can schedule a case to an available OR. Block scheduling provides a set time for a surgeon (or a surgical service) in which to schedule a case. Once blocks of time are allocated, the concern in time usage becomes significant as unused time leads to inefficiency. With a modified block schedule some cases are booked into block times and unused time is made available to other surgeons. The complexity of establishing an OR schedule is complicated by conflicting interests of staff (i.e., surgeons, OR managers, nurses, and anesthetists) who want to add patients to the schedule for their own particular reasons (Guerriero & Guido, 2011). However, Guerriero and Guido (2011) suggest that scheduling problems can be managed by (a) selecting the patients, (b) assigning the patients to the surgeon, and (c) determining the surgery date.

The culture in the delivery of care in the OR must change from what is best for the surgeon to what is best for the hospital (Smith et al., 2013). Heiser (2013) suggested that an OR governance structure led by an OR executive committee be instituted to improve OR scheduling. This OR executive committee was comprised of the OR director, surgery department medical director, and a representative from hospital administration. They will be charged with growing surgical services by marketing the surgical program, ensuring that patient and surgeon needs are met, increasing OR revenue, and developing the surgical strategic plans. Additionally, an OR advisory committee can be developed comprised of an administrator who has oversight of the OR and surgical staff leadership, such as the surgical department chair and anesthesia chair, that will advise the OR executive committee and communicate with the surgical staff

(Heiser, 2013). Peters and Dean (2011) also recommended the development of a surgical services committee led by physicians who had good rapport with hospital administration and were influential with their peers to address improvements to the OR. In an evaluation of such a group, they found that a surgical services committee was successful in changing the four hour block schedules currently in place to an eight hour block schedule because it was determined that four hour blocks did not allow for efficiently accommodating multiple procedures. The surgical services committee was also successful in establishing that a 75% utilization rate was necessary in order to maintain a surgeon's block schedule. In a community hospital described in a case study, a redesigned pre-operative process and morning huddles between the surgery director, OR nurse supervisor, and pre-operative supervisor to review the cases to be added to the surgery schedule increased block utilization and decreased overtime costs (Peters & Dean, 2011).

Efficient ORs have the ability to increase the number of cases that can be completed within a block of allocated time without incurring overtime costs (Ferrari, Micheli, Whiteley, Chazaro, & Zurakowski, 2011). In a quasi-experimental study within one organization, Ferrari et al. (2011) showed that this was accomplished by (a) staggering nursing shifts that exceeded the blocked times, (b) ensuring that surgical services demonstrate 80% utilization of allocated blocks before additional block times are granted, (c) allocating turnover times based on procedures when developing schedules, (d) emphasizing that cases start on time, and (e) providing constant feedback of on-time starts and the use of block time to staff. Cases that did not start at the scheduled time incurred overtime costs.

In a prospective case study in a single institution, Smith et al. (2013) used variability theory to manage the flow of patients into the OR. Use of variability theory in patient flow takes into account two types of variation: (a) natural variation, which cannot be controlled such as an emergency or unscheduled case, and (b) artificial variation, which can be controlled. The hospital resource demands for scheduled and unscheduled cases are different. The utility of variability theory is that it promotes smoothing out the schedule so that it is predictable and reliable (Smith et al., 2013). Furthermore, more surgeries can be performed without incurring more cost by applying variability theory, but staff and the OR culture must be assessed for their willingness to accept change in the way surgical services are delivered (Smith et al., 2013). Staff buy-in with performance improvement initiatives will ensure the sustainability of the changes to their practice.

Operating Room Efficiency

Delays to Start Time

OR efficiency is closely tied to OR utilization. Li et al. (2013), as part of their Lean Six Sigma project, identified the root causes for their low OR utilization rates using a fishbone diagram. This fishbone diagram included on-time start and TOT as contributing factors. Delays related to the start of cases, especially FCSs, and prolonged room turnover time cause delays to the next scheduled case in the OR suite. Inefficiencies can result in increased costs due to staff down time and possible overtime. In a single center prospective observational study, Porta et al. (2013) found that the average OR delay was 17.3 minutes depending on the surgical service. These authors specifically identified OR delays that were attributed to TOT, nursing issues, surgeon issues, and patient flow issues (Porta et al., 2013). In order to mitigate the effects of these delays, a post-operative debriefing was implemented to discuss the factors that contributed to the delay in surgery. After the implementation of the post-operative debriefing process, Porta et al. (2013) found that the mean delays decreased 9% and gained 212 minutes of extra OR time per month. The extra minutes gained for the month decreased the cost of overtime, but it did not allow for adding another case per day to the surgery schedule. Any trends to OR delays were presented at the bi-monthly OR utilization management group meeting for corrective action (Porta et al., 2013).

As mentioned above, the institution of an OR governance structure can lead to improvements in the manner with which services are rendered. A medical team training executive council was developed as part of a quality improvement project to address OR team performance and OR delays (Wolf, Way, & Stewart, 2010). All OR staff attended a one day medical team training focused on systems thinking, improving teamwork, and the use of a briefing and debriefing checklist to identify any systems issues impacting OR services. Any issues that were identified during the briefing and debriefing sessions were brought to the attention of the medical team training executive council for corrective action. As a result, Wolf et al. (2010) found that delays decreased from 32% to 19%.

An observational study by Higgins, Bryant, Villanueva, and Kitto (2011) determined that OR delays were related to unanticipated problems with the clinical presentation of the patient prior to surgery as well as surgeon tardiness. The former causes cases to be cancelled, which significantly impacts the OR schedule and utilization rates. The latter delays the case, which can directly impact the start time of the case that follows, cause cancellations to cases scheduled later in the day, and lead to overtime costs due to the extension of the work day. Delays at the start of cases, particularly FCS, can have a significant impact on any OR schedule as they can lead to overtime and extending hours beyond the scheduled end time for the day. Delays that are not within staff control cannot be avoided, but those that are within staff control must be addressed to improve OR efficiency. Does et al. (2009) found that the most important factors in delays to start times were poor planning and scheduling. Poor planning was related to a vague process in which patients were prepared for surgery, such as poor instructions regarding the time the patient is expected to arrive in the pre-operative area, time anesthesia should be available, and time for premedication. A quality improvement project was implemented that altered the planning process to have the patient (a) arrive to the OR no later than 0735 in hospital A and 0800 in hospital B, (b) receive pre-operative medication before arrival to the OR, and (c) the referring department and anesthesia being informed of the scheduled procedure one day in advance. As a result of this new process, delays decreased 25% in hospital A and more than 30% in hospital B. Both hospitals decreased delays in start times, decreased cost, and increased quality without increasing resources to do so.

Delays related to surgeon unavailability are a significant concern that affects OR utilization (Higgins et al., 2011; Meredith, Grove, Walley, Young, & Macintyre, 2011; Wright, Roche, & Khoury, 2010). Wright et al. (2010) found that the most common delays were related to surgeon and anesthesiologist unavailability. As part of their quality improvement project to address these delays, a pre-operative huddle at 0735 was implemented to serve as a venue for communicating pertinent information regarding the cases for the day. The surgeon, anesthesiologist, and nursing staff participated in this pre-operative huddle. This was the single most effective strategy for improving on-time starts. As a result, on-time start improved from 6% to 60%. An extra 15 minutes were gained by starting on-time, but this did not yield any additional cases to be performed (Wright et al., 2010). The inability to add a case to the schedule by virtue of extra time gained by starting on-time is echoed by Pandit, Abbott, Pandit, Kapila, and Abraham (2012). These authors found that on-time starts did not impact efficiency in their study as the "start and finish times were poorly correlated at both hospitals (r2 = 0.077 and 0.043)" (Pandit et al., 2012, p. 823). Pandit et al. (2012) acknowledge the need for staff to report to work as scheduled, but found that use of on-time start as a metric for productivity was not associated with OR efficiency. They concluded that developing a proper OR schedule that calculates the finish time would be a better metric for OR efficiency. A fixed start time is not the only measure that can be explored to determine improved OR efficiency and utilization. Despite these findings, there are still costs related to delays to start times, especially FCS, and a culture of accountability must be upheld.

Interestingly, OR efficiency is perceived differently by OR staff compared to those in a leadership position. In a qualitative study, Arakelian, Gunningberg, and Larsson (2008) inquired about the manner in which staff and leadership understood OR efficiency by asking the following questions: (a) What do you think about when I say "workflow?" (b) What do you think about when I say "obstacles?" (c) What does the word "efficiency" or "being efficient" mean to you? The authors found that staff understood OR efficiency in terms of individual competence focusing on knowledge and experience along with creating a smooth work flow. On the other hand, leadership understood OR efficiency in terms of productivity, specifically completing work that is assigned and the amount of work produced per time unit (Arakelian et al., 2008). In another qualitative study, Arakelian et al. (2011) explored OR efficiency and found that staff described seven ways of understanding the phenomenon. The seven ways are: (a) be proactive, (b) enjoy the work that you do and be adaptable to different situations, (c) work synergistically with team members, (d) achieve desired results without increasing resources to do so, (e) work fast, but maintain quality of care, (f) invest in resources to achieve long-term gains for patient health, and (g) efficiency is achieved with experience (Arakelian et al., 2011). Providing quality patient care was central to the way efficiency was understood.

Operating Room Turnover Time

Operating room turnover time can be defined in different ways. In an observational study in five organizations using video analysis, Meredith et al. (2011) defined TOT from the last stitch of a patient to the incision of the next patient, specifically all activities excluding the actual surgery. In a performance improvement project implementing Lean Six Sigma, Li et al. (2013) defined TOT as patient wheels out time to the next patient wheels in time. The SCCH uses the same definition as Li et al. (2013).

Delays in TOT can be impacted by equipment availability, availability of staff to turn over the room, or readiness of the next patient (Li et al., 2013). Meredith et al. (2011) observed that there are three critical phases in TOT: (a) patient removal, (b) patient transition, (c) operation preparation. The efficiency with which each of these phases is completed contributes to the improvement of TOT. White space, which is time with no surgical activity occurring, contributes to inefficiency and waste. Examples of white space include instrument preparation and positioning of the patient as well as waiting for surgical staff or the patient. The availability of surgeons in the OR suite also impacted TOT as surgeons were observed to motivate and assist staff with duties other than surgery (Meredith et al., 2011).

An accurate, objective measurement of TOT is important as ORs function based on a time schedule. Any delays to the schedule impacts OR efficiency and utilization. Masursky, Dexter, Isaacson, and Nussmeier (2011) found that surgeons and anesthesiologists who were surveyed overestimated TOT. Therefore, surgeons and anesthesiologists cannot be relied upon when developing the OR schedule. Accurate measures for TOT are needed to develop a consistent and reliable OR schedule. Masursky et al. (2011) points out that other factors beyond time must be taken into consideration when evaluating TOT, such as team activity and attitude about the facility. Securing a better understanding of the delays related to TOT yields a more comprehensive picture of the contributing factors that affect OR efficiency.

METHODS

Setting

The quality improvement project was conducted at a SCCH. This hospital has five ORs that provide specialty surgical services in 21 categories.

Data Collection

The sample was comprised of archival data related to delays with FCS in the OR and TOT. Data were collected from June 18, 2014 to October 31, 2014. FCS was defined as the time that the first patient of the day entered any OR suite. TOT was defined as the time the patient exited the OR suite to the time that the room was properly cleaned by the EVS staff indicating that it was ready to safely receive the next patient. All elective surgical procedures were included in the evaluation for FCS and TOT, while all urgent surgical cases were excluded. There were no emergency services in this facility.

First Case Start

The compliance rate with on-time FCS was calculated by the total number of on-time FCS divided by the total number of first cases of the day. A frequency distribution table and graph was used to indicate the delays to FCS based on the documentation of circulating nursing with the pre-operative huddle. The compliance rate with nursing documentation of surgical delays was calculated by the total number of cases with documentation divided by the total number of cases. The pre-operative huddle compliance rate was calculated by the total number of pre-operative huddles conducted 15 minutes before the scheduled start time divided by the total number of surgical cases. Additionally, the compliance rate with the pre-operative huddle and its impact on FCS was evaluated by comparing the total number of pre-operative huddles 15 minutes before the scheduled start time to the total number of on-time FCS. All of the above data were generated for the overall OR service and by each surgical service.

Turnover Time

A mean of the TOT by surgical service was calculated based on the EVS log documenting the cleaning of the OR suite once the patient was wheeled out of the room.

RESULTS

Archival data were used for data analysis related to delays with FCS and TOT. Additional statistical analysis beyond what was proposed in the Doctor of Nursing Practice (DNP) Project Proposal was used to further explain the data. SAS version 9.3 was used to run statistical analyses.

First Case Start

Data were obtained for 212 FCS in the study period of June 18, 2014 to October 30, 2014. Fifty-five percent of first cases for the day started on-time. Surgeon tardiness, other staff and internal factors, and patient induced delays accounted for 28%, 11%, and 6%, respectively. During the period of observation, the goal of having patients in the OR suite on time for at least half of first of the day surgical cases was attained 72.4% of the time. A comparison of the means with FCS delays during the first and last five weeks of the observation period revealed a 34% decrease in delays with FCS (See Figure 2).
A pre-operative huddle before the start of all first case surgeries of the day occurred 82.9% (n = 189). The presence of the surgeon, anesthesia, pre-operative nurse, and circulating nurse at the huddles were 50.9%, 86.3%, 90.1%, and 92.0%, respectively. Surgeons accounted for 60 delays with FCS and they did not participate in a huddle 52 times. A series of chi-square tests of independence were run to determine whether conducting a huddle and surgeon attendance were related to the type and frequencies of delays (see Table 1). The chi-square tests revealed that FCS were on-time 12.6% more often when a huddle took place and 37.5% more often when the surgeon was present. When a huddle occurred surgeons were absent 30.2% of the time. When a huddle did

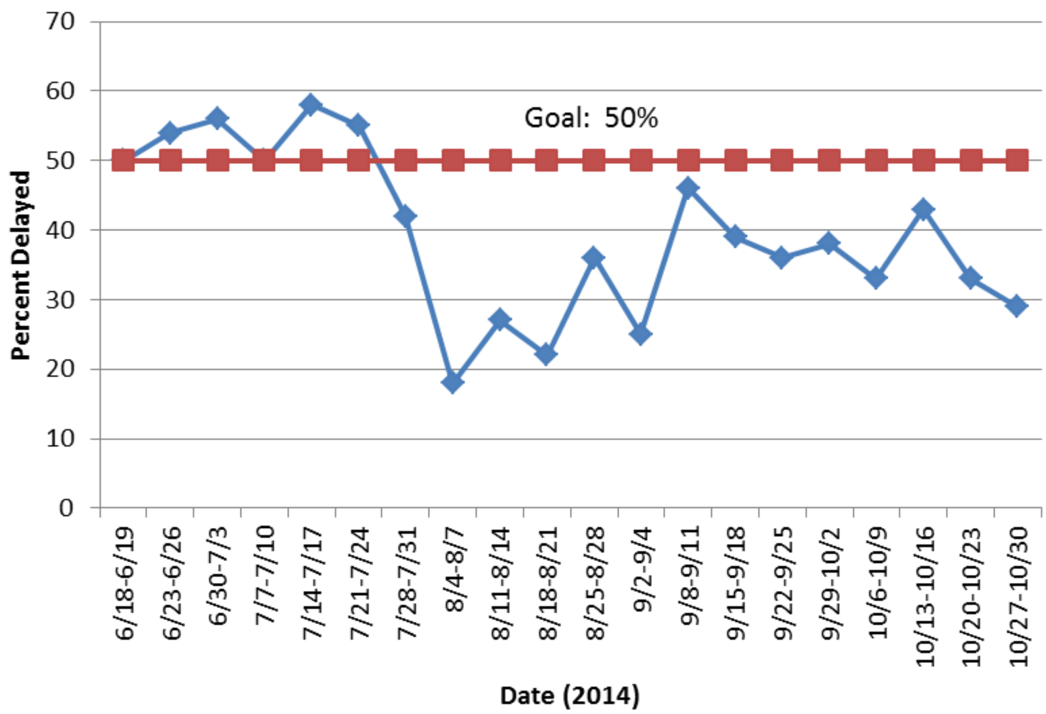


Figure 2. Percent delays with first case starts for all surgical services excluding delays that were patient driven.

Table 1

Impact of Huddle and Surgeon Participation on Case Delays

		Reason for Delay								
Variable	Overall	Surgeon Absent		Other Staff and Internal Factors		Patient Late		No Delay		x^2 p - value
Huddle	n	n	%	n	%	n	%	n	%	.002
Yes	189	57	30.2	16	8.5	10	5.3	106	56.1	
No	23	3	13.0	8	34.8	2	8.7	10	43.5	
Surgeon Present	108	8	7.4	15	13.9	6	5.6	79	73.1	<.001
Not Present	104	52	50.0	9	8.7	6	5.6	47	35.6	

not take place 34.8% of delays with FCS were attributed to the absence of the other OR team members (anesthesiologist, pre-operative nurse, or circulating nurse) or internal factors that were within the control of the staff to ensure that cases were not delayed such as missing consents and pending labs or diagnostic results. This implies that a huddle significantly decreases delays with FCS. A simple logistic regression revealed that the absence of the surgeon during the pre-operative huddle increased the odds of a delay with FCS over five-fold (OR 5.663, 95% CI [3.051-10.510]). The probability of a delayed surgery, given the absence of the surgeon, can be explained by the logistic regression model: $\text{logit}(p) = \ln[p/(1-p)] = -1.2 + 1.7X_{surgeon}$. Based on this model, a one-unit increase in the surgeon variable corresponds to a 1.7339 increase in the log odds of a surgical delay.

The Arthritis, Neurosurgery, Sports Medicine and Urology surgical services had the highest number of surgeon delays while the General and ODA services had the fewest. (See Figure 3). Average delays were longest when caused by patients (M = 29.4 minutes, range 2-84), followed by surgeons (M = 29.2 minutes, range 5-105), and then other OR staff and internal factors (M = 22.2 minutes, range 3-105). The cost to run the OR per minute was $51.86. Average cost due to delays with FCS were highest with the patients (M = $1525.55, range $103.72-$4356.24) followed by surgeons (M = $1512.58, range $259.30-$5445.30) and other OR staff and internal factors (M = $1149.56, range $155.58-$5445.30). The overall financial impact of delays with FCS that were within staff control was $118,344.52. Surgeon tardiness accounted for $90,755.00 with the top four costliest surgical services due to delays with FCS being Arthritis ($23,025.84), Neurosurgery ($18,980.76), Sports Medicine ($13,483.60), and Urology ($9,334.80).

Conversely, the least costly surgical services were Ortho-diabetes, Pressure Ulcer Management, and Otolaryngology (see Figure 4). Patient induced delays that were beyond the control of the staff cost $18,306.58.

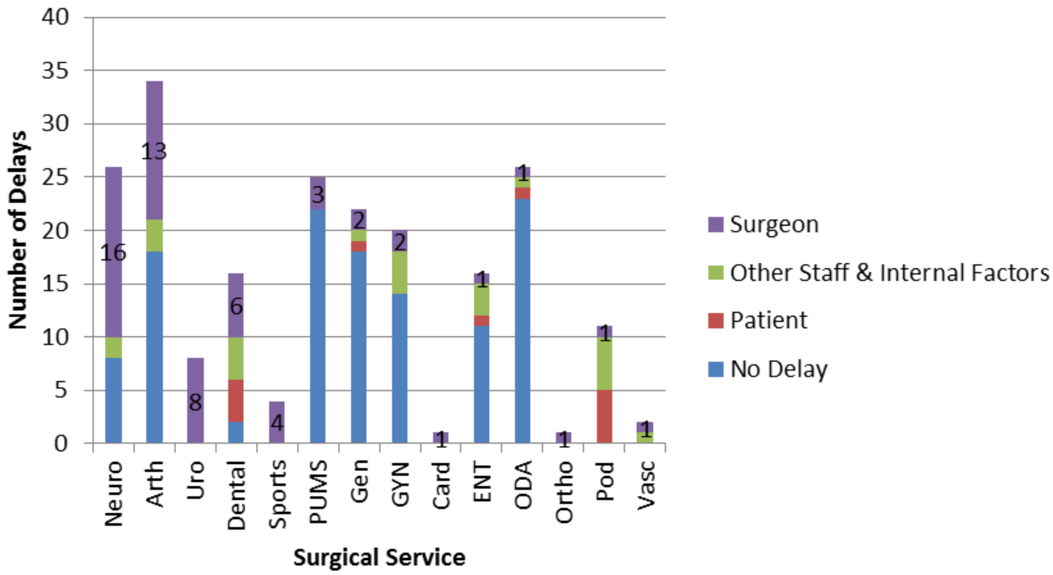


Figure 3. Delays with First Case Starts and the type of surgical service.
Neuro = neurology; Arth = arthritis; Uro = urology; Sports = sports medicine; PUMS = pressure ulcer management service; Gen = general; GYN = gynecology; Card = cardiology; ENT = ear, nose, and throat; ODA = orthopedic diabetes amputation; Ortho = orthopedic rehabilitation; Pod = podiatry; Vasc = vascular.

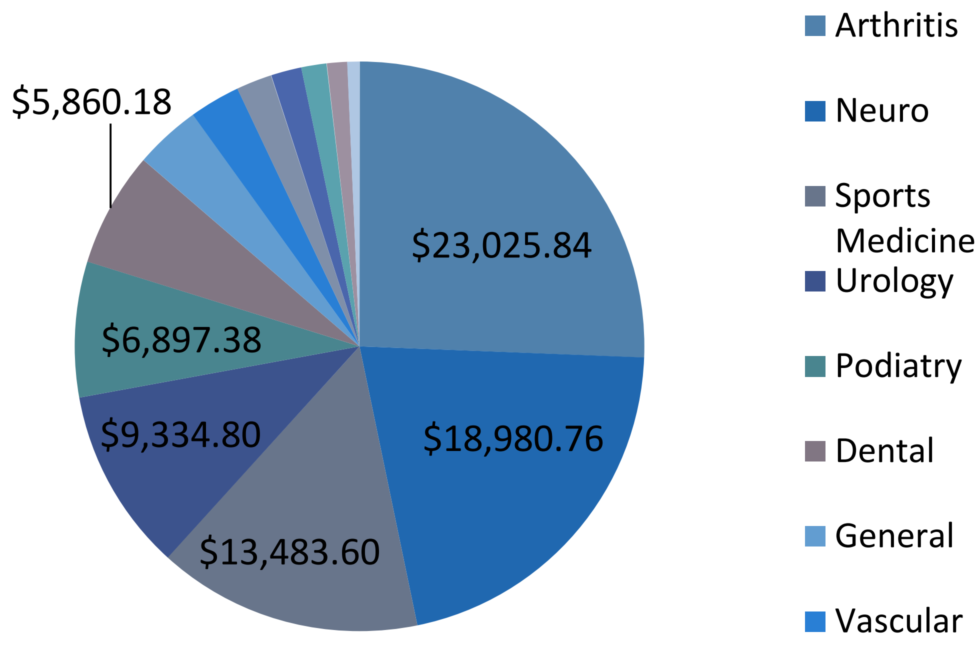


Figure 4. Cost of delays by surgical service.

Turnover Time

The surgical service with the highest TOT rounded to the whole minute was Sports Medicine at 30 minutes. The Podiatry service had the lowest TOT at 15 minutes. The TOT for all of the other services was between 18 to 20 minutes.

DISCUSSION

The goals for this QI project were met as at least 50% of surgical cases scheduled first at a SCCH entered the OR suite(s) at the scheduled time and a baseline average OR suite TOT was established for each surgical service. The process measures related to FCS were all met as evidenced by the establishment of an OR workgroup, documenting FCS and the reasons for delays via the Surgical Start Time Log, all of the circulating nurses completed the Surgical Start Time Log, the frequency of delays by surgical service was determined, and at least 50% of the surgeons participated in the huddles. In regards to the process measures with TOT, all of the process measures were achieved with the exception of the EVS supervisors conducting weekly observations of OR cleaning between surgical cases. A log was developed and utilized by the EVS staff to document the length of time needed to clean an OR suite for each surgical service.

This QI project identified inefficiencies in the OR related to delays with FCS while also establishing a baseline average of OR TOT for each surgical service. OR efficiency is closely tied to OR utilization. OR utilization is impacted by starting cases on-time and TOT (Li et al., 2013). Delays with FCS combined with prolonged TOT can cause delays with the next scheduled case in the OR suite. The majority of first case surgeries started on-time. Delays with FCS resulted for a myriad of reasons with most delays falling within the realm of staff control, such as surgeon tardiness, incomplete or missing documentation, and labs or diagnostic results that were unavailable. These types of delays must be addressed to improve OR efficiency. A comprehensive approach and the involvement of different disciplines may be required to achieve changes to improve

OR efficiency (Ranganathan, Khanapurkar, & Divatia, 2013) as evidenced by the implementation of this QI project.

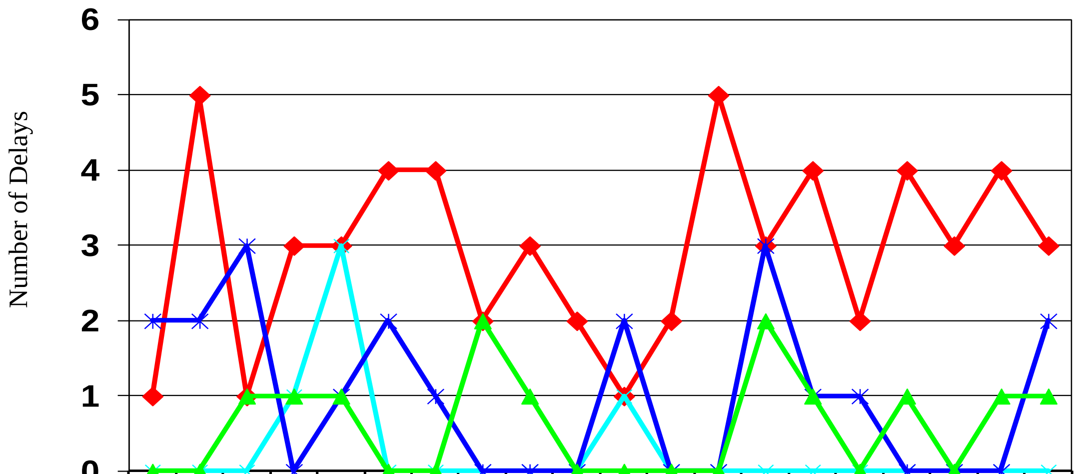
The Administrative Team and OR workgroup were established to improve OR efficiency. The Administrative Team was comprised of the CEO, Chief Quality Improvement Officer, the physician champion for the Medical/Surgical System of Care, the Nurse Manager for the Medical/Surgical System of Care (Project Leader), and the Interim Chief Clinical Officer. The OR workgroup consisted of a surgeon, an anesthesiologist, an OR nurse, EVS leadership, and the Project Leader. The Project Leader scheduled an initial meeting with the OR workgroup to inform them of the goals and objectives for the DNP Project. The Project Leader continued to meet with the OR workgroup periodically throughout the project to discuss the progress towards meeting the goals and objectives. This workgroup was charged with addressing FCS and TOT and ensuring that the project goals were met. Constant communication between the OR workgroup and the administrative team was maintained. Any concerns that were identified or expressed by the OR workgroup were addressed by the administrative team to continually move towards decreasing surgical delays.

The administrative team and the OR workgroup collaborated and established a pre-operative huddle at least 15 minutes before the scheduled FCS time for each elective surgery to address various causes for late starts. The circulating nursing staff was charged with documenting the time of the pre-operative huddle, participants (surgeon, anesthesiologist, pre-operative nurse, and circulating nurse), surgical service, any delays to FCS, scheduled FCS, and actual FCS. The surgeon’s presence pre-operatively was critical because it triggered a domino effect to expedite patient progress from the pre-operative area to the OR suite or not based upon the patient's clinical presentation. The case was cancelled if the surgeon determined that the patient's condition was not suitable for surgery. If the patient was ready for surgery, then an updated history and physical assessment was required per the Centers for Medicare and Medicaid Services, the completion of surgical consent forms, pre-medication, as well as the initiation of opening sterile equipment in the OR suite were all triggered by the surgeon's determination to proceed with the case.

A review of the OR documentation system used by the OR staff (surgeons, anesthesiologists, and nurses) was conducted to determine the sections that housed information related to the start time of cases. Prior to the start of the DNP Project, surgeons were the only discipline who documented the cause of delays to surgical cases in the OR documentation system. A report from the Information Systems department indicated that from January 1, 2013 to December 31, 2013, there were only 31 delays to surgical cases that documented delays with FCS. Of the 31 documented delays, 26 cases were documented to have no delays, which was inaccurate because further investigation into these cases revealed that the actual FCS exceeded the scheduled FCS.

In order to accurately capture FCS, all of the circulating nurses completed the Surgical Start Time Log (Appendix A) daily. Any missing data elements were discussed with the circulating nurse that completed the form. The circulating nurses documented the reasons for surgical delays. Delays ranged from those that were within staff control to those that were not. Only the delays within staff control were addressed.

FCS data were calculated weekly and graphs were strategically displayed in several areas in the OR that were clearly visible to all staff. These graphs highlighted the compliance rate with FCS from the previous week that were staff driven (See Figure 2), the reasons for delays with FCS (see Figure 5), and the amount of delay with FCS by surgeon (See Figure 6). These graphs clearly pointed out the reasons for the delays with FCS.



	6/18-6/19	6/23-6/26	6/30-7/3	7/7-7/10	7/14-7/17	7/21-7/24	7/28-7/31	8/4-8/7	8/11-8/14	8/18-8/21	8/25-8/28	9/2-9/4	9/8-9/11	9/15-9/18	9/22-9/25	9/29-10/2	10/6-10/9	10/14-10/16	10/20-10/23	10/27-10/30
Surgeon	1	5	1	3	3	4	4	2	3	2	1	2	5	3	4	2	4	3	4	3
Anesthesia	0	0	0	1	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Other	2	2	3	0	1	2	1	0	0	0	2	0	0	3	1	1	0	0	0	2
Patient	0	0	1	1	1	0	0	2	1	0	0	0	0	2	1	0	1	0	1	1

Figure 5. Reasons for delays with first case starts.

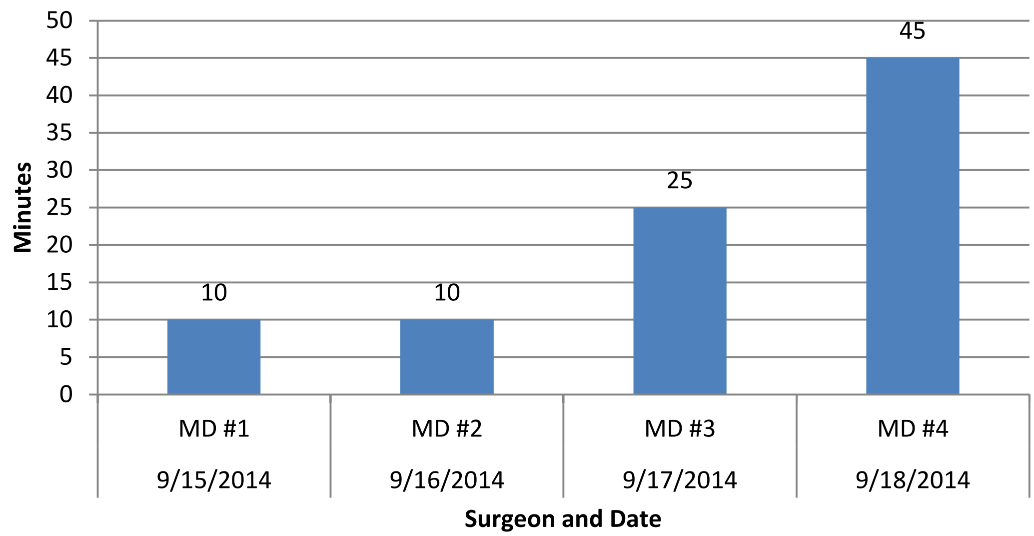


Figure 6. Delays in minutes with first case starts by surgeon.

The implementation of a pre-operative huddle promotes teamwork. Paige, Aaron, Yang, Howell, and Chauvin (2009) found that a pre-operative huddle improved teamwork by defining the roles and responsibilities of each team member and allowing them to meet face to face to discuss any matters that may affect surgery. Each member of the OR team is embraced as critical to ensure that each patient receives quality patient care and the health and that the well-being of the patient is protected. The huddle increases communication amongst the team members as each discipline is able to discuss critical information about the patient and his/her surgery either individually between team members or collectively. Once the surgeon decides to proceed with the case, each team member can complete his/her assigned tasks in parallel rather than serially and efficiently move the patient closer to surgery. The silo mentality is minimized because all members are focused on the same task of providing a service that the patient needs. This collaborative environment increases OR efficiency.

The pre-operative huddle showed a profound impact on decreasing delays with FCS. The pre-operative huddle appears to have a surgeon bias with delays to FCS. Based on the data, having the surgeon absent during the huddle seems to be the biggest predictor of delays with FCS. The surgeon's unavailability affects OR utilization (Higgins et al., 2011; Meredith et al., 2011; Wright et al., 2010). Wright et al. (2010) found that the most common surgical delays were associated with the unavailability of surgeons. The surgeon makes the final determination as to whether or not to proceed with the surgery based on his/her assessment of the patient. If the patient's condition is not conducive to surgery, such as the presence of fever, high blood sugar, or abnormal lab or diagnostic results, then the case will either be cancelled or postponed until the patient is medically stable. As a result, delays can have a significant impact on the OR schedule as it can lead to extending the hours of operation beyond the scheduled end time for the day, thus incurring overtime costs.

A paradigm shift from what is best for the surgeon to what is best for the hospital is imperative in developing efficient ORs (Smith et al., 2013). This paradigm shift may also improve patient satisfaction. Fezza and Palermo (2011) determined that surgeon tardiness was a major contributing factor with delays to FCS. They implemented strategies that focused on surgeons reporting 20 minutes before their first case and documenting their arrival time. These initiatives focused on physician accountability, which resulted in decreasing delays with FCS. Surgeons who lead by example, advocate for change, and align with the hospital's goals decreased delays with FCS and average TOT (Attarian, Wahl, Wellman, & Bolognesi, 2013). Additionally, the development of a surgical services committee led by physicians who had good rapport with hospital administration and were influential with their peers led to improvements in the OR (Peters & Dean, 2011).

The OR is an expensive department to operate (Does et al., 2009; Guerriero & Guido, 2011; Peters & Dean, 2011) and inefficiencies in the OR increase operational costs even further. If the surgeon is not present, then the case cannot proceed. While in this holding pattern, the other members of the OR team are continuing to earn their wages. More importantly, starting a case later than it is scheduled will extend the work day beyond the regular end of the shift and incur overtime costs.

Another advantage to implementing a pre-operative huddle is the potential for improving patient satisfaction. Patients can witness the teamwork that is exhibited by the team. They can be assured that their best interests are a priority because all members of the surgery team are dedicated to work as efficiently as possible while ensuring patient safety. The parallel processing implies that all team members are dedicated to starting the surgery as scheduled. Patients can sense that their time is respected as staff work to minimize delays from the moment they present to the pre-operative suite to entering the OR for surgery. This is especially true for outpatient procedures as the patient's loved ones are waiting to take the patient home.

The other inefficiency that was identified in this quality improvement project that affected OR efficiency was TOT. Prior to this project, there was no objective measurement for the average TOT required for cleaning an OR suite for each surgical service. Relying on a subjective measurement for TOT is unreliable as surgeons and anesthesiologists in particular overestimate TOT (Masursky et al., 2011). The average TOT information can improve the process with scheduling surgeries. If the OR scheduler is equipped with the estimated length of a proposed surgery and the average TOT required for cleaning the OR after the case, then they can determine the maximum number of cases that a particular OR can occupy without risking overtime costs. Additionally, scheduling cases with shorter duration require more frequent turnover, thus requiring more staff for cleaning the OR suites.

The EVS staff documented the time in and time out when cleaning a specific OR. Initially, the EVS staff was asked to report the surgical service that was completed in the OR suite that needed cleaning. They were unable to identify the surgical service and a change was made to report the surgeon that performed the surgery as this information was readily available on the OR board that indicates the OR suite, procedure, and surgeon. The Project Leader was able to identify the surgical service based on the surgeon. The EVS Director entered the TOT on an Excel spread sheet that facilitated data analysis. The baseline data of average TOT by surgical service was reported to the administrative team for review and consideration with respect to OR utilization and scheduling of cases.

EVS supervision was charged with ensuring that the OR suites undergo thorough cleaning between surgical cases to ensure that the health and safety of patients along with the OR staff were protected. Random audits by the EVS supervisors were conducted to ensure that the EVS staff was following their established protocols for cleaning as it was undesirable to minimize the TOT at the expense of patient and staff safety. EVS leadership was unable to conduct random weekly audits of the EVS staff citing difficulty with determining the end times of scheduled surgical cases. Six audits were conducted in a span of four weeks during the study period. EVS supervision presented to the OR at random times with the intent of conducting the random audits, but their timing typically did not coincide with the patient's exit from the OR suite and the start time for cleaning by their staff. As an alternative to presenting at random times to conduct the audits, EVS leadership was provided with a list comprised of the average length of surgery by service coupled with an arrangement with nursing to provide them with the OR schedule the day before. The intent was to arm EVS leadership with a better method of estimating when to present to the OR to conduct the weekly random audits. However, competing priorities within the EVS department did not allow for meeting the goal of weekly random audits.

Overall, this QI project was well received by the Administrative team and all members of the surgical staff. The Administrative team dedicated resources to ensure the achievement of the project's goals. They recommended that the delays to FCS be added to the hospital's portal that displays different QI projects within the organization. This portal is accessible to all staff. They identified administrative support staff who printed color copies of the graphs that were displayed in the OR. They were supportive of including the names of the surgeons that contributed to delays not for the purpose of being punitive, but rather to insert accountability for the delays. Hospital Administration has determined that this strategy has been effective in improving practice for other QI projects especially when physicians were involved. The Administrative team requested that reports be provided to the hospital Executive Council regarding OR efficiency and utilization to achieve transparency with the data. Executive Council discussed the data and acknowledged its value. They offered their continued support to achieve the project's goals. They expected the Chief Medical Officer to convey the results of the data to the surgical leadership who will in turn implement strategies, such as counseling surgeons who exhibit consistent delays with FCS, to ensure that continual improvements are achieved.

The OR nurses were the driving force behind this QI project. Nursing embraced the opportunity to improve OR efficiency by playing an integral role in determining the reasons for delays with FCS. They welcomed the responsibility of documenting all elements of the Surgical Start Time Log and openly asked questions to ensure the accuracy of the data they reported. The Nurse Manager altered the start time of the circulating nurses from 7:00AM to 6:45AM to allow ample time to prepare their assigned OR suite and participate in the pre-operative huddle. When elements of the log were overlooked by the nurse assigned to the case, the nurse at the front desk promptly called him/her to complete the form. The nurses readily provided insight into OR operations that may improve the QI project. For instance, the accuracy of the start time documentation was questioned by the surgeons citing that the clocks in different OR suites varied. Nursing was proactive in submitting a work order with Facilities Management to ensure that all of the clocks in the OR suites were synchronized. Nursing expressed their appreciation for the increased efficiency that was achieved with starting on-time.

This QI project was also well received by the anesthesiologists. The Chief of Anesthesiology noted that the huddle did not alter their daily practice as they report at 6:00AM when patients are requested to present to the pre-operative area. The staff was extremely receptive to any incidents in which they were identified as contributing to a delay with FCS. The Chief was diligent about communicating with the circulating nurses to determine the rationale for anesthesia related delays. The contributing factors were promptly addressed by the Chief to ensure that it was not repeated.

The EVS staff was receptive of this QI project. They acknowledged the importance of their role with establishing an average TOT by the different surgical services. One barrier that was identified early in the process was the inability of the EVS staff to identify the surgical service that concluded prior to the requirement for cleaning. As a result, a process change was made that requested they document the surgeon on their log instead of the surgical service. The surgery board clearly identified the OR suite and the corresponding surgeon who performed the surgery. When the data were analyzed by the Project Leader the surgeon was converted to the surgical service. Data were analyzed in the early stages of the project and it revealed that the TOT averaged 15 minutes for all surgical services raising questions about the validity of the data. A one-on-one discussion with the EVS staff revealed that the reported TOT was rounded up to the nearest five minutes. For example, if the total cleaning time was 12 minutes then it was rounded up to 15 minutes. The rationale for securing an accurate TOT was discussed with the EVS staff and they agreed to change their process and document the exact time they started and finished with the cleaning of the OR suite rather than rounding up to the nearest five minutes.

The surgeons accepted this QI project. The surgeons had to make the biggest adjustment with the implementation of the pre-operative huddle. Surgeons did not conduct surgeries every day, yet they were expected to report at least 15 minutes prior to the first scheduled surgery. The majority of the surgeons adjusted well to the pre-operative huddle while others continued to struggle. The Chiefs of the surgical service sought clarification regarding the manner in which the data were collected and relayed this information to the surgeons that they supervised. They emphasized the importance of participating in the huddles. They reviewed the reasons for surgeon related delays to FCS and provided coaching which emphasized surgeons' participation in the pre-operative huddle to ensure that cases started on-time. One of the Chiefs of Surgery expressed that their surgeons did not appreciate having their names and the minutes of delay published for the remainder of the OR staff to review. However, they acknowledged its impact with increasing accountability for starting cases on-time, especially as the project progressed. This Chief also acknowledged that the practice of identifying delinquent physicians with other QI projects is routine for the organization and has proven to be effective in achieving improvements in practice.

In the early stages of the project some of the surgeons approached the circulating nurses and questioned them about the details regarding data collection. Some of the surgeons inquired about who was responsible for determining the causes for delays with FCS as well as the criteria that were used in making the determination. Some of the surgeons questioned the accuracy of the data that was collected and these questions were raised to the circulating nurses. One nurse recalled that a surgeon vocalized the time of his arrival at the huddle and the time that the patient began to leave the pre-operative suite in order to emphasize that the case was not to be reported as delayed. Another nurse stated that there was a disagreement between the surgeon and the nurse with the documented time that the patient entered the OR suite which resulted in the surgeon remarking that the Surgical Start Time Log needed to be revised to reflect his version of the time that was not a delay. In the end, the nurse submitted the time that the patient arrived in the OR suite which was after the scheduled start time. Despite these incidents the majority of the surgeons accepted the process with documenting any delays with FCS. In fact, the nurses indicated that as the project progressed the surgeons were more receptive to the process with documenting delays with FCS and less inquiries were made that challenged the validity of the data that was collected. Interestingly, surgeons did not raise any questions regarding the data collection process to the attention of the Project Leader. This may be attributed to the discrepancy with which the OR nurses and the Project Leader spent in the OR. The surgeons found the OR nurses to be readily available when concerns arose.

Limitations

This QI project had several limitations. The surgical start time log was completed by the circulating nurses and there may be an element of bias in recording the reasons for delays, particularly with circulating nurse delays. The circulating nurses were educated regarding the rationale for the project and were charged with determining the cause of any delays with FCS. The results for this QI project may not be applicable to other institutions that operate differently than county facilities. Despite the similarity, this project may yield valuable information regarding the impact of a pre-operative huddle using the Surgical Start Time Log. The improvements in OR efficiency by decreasing delays with FCS may not increase OR utilization by adding additional cases at the end of the day (Pandit et al., 2012; Wright et al., 2010). The improvements with decreasing delays with FCS may not directly result in improving patient satisfaction. Patient satisfaction was not directly studied in this QI project as the focus was on the processes related to delays with FCS.

There were also limitations with the TOT data. Again, there may be some bias with documentation of TOT as the EVS staff self-reported the amount of time required with the cleaning of an OR suite. The EVS leadership was asked to conduct random audits to validate the data reported by the line staff, but was only able to do so on six occasions during the project period. Once again, the EVS line staff was briefed on the rationale for the project. The interpretation may have led them to focus on the speed with cleaning and equating this with increased efficiency rather than the thoroughness with cleaning and ensuring patient safety. There were no surgical site infections that were reported during the study period.

Recommendations

This QI project showed that the implementation of a pre-operative huddle decreased delays with FCS while also establishing a baseline average of OR TOT for each surgical service. First, it is important to continue monitoring the data with delays to FCS to achieve a goal of zero delays. The graphical presentation of the data in areas that are visible to all OR staff is to be continued to emphasize the importance of improving on-time starts and clearly identifying the cause for delays. Second, establish a dedicated time for OR staff training that focuses on the rationale and process with conducting a pre-operative huddle, enhancing teamwork, and the use of the tool to improve OR efficiency. Conduct a separate staff training with EVS that focuses on the importance of their role in improving OR efficiency, thorough cleaning rather than the speed with TOT, and the use of the TOT log. This training will educate staff with the critical metrics that track delays and how they are measured. Third, incorporate the elements of the Surgical Start Time Log into an electronic health record to facilitate the entry and analysis of the data, thus decreasing the resources needed to do so. Data will be archived and can easily be extracted for future use in a multitude of ways. Fourth, make the attendance of the pre-operative huddle by all members of the team a standard, expected practice and perhaps developing a policy and procedure for all surgical staff to participate in the pre-operative huddle. The pre-operative huddle is currently voluntary, but the results of the QI project clearly demonstrate its value. There is no established process for addressing surgeons who choose not to participate in the huddle. Fifth, establish a process for coaching staff that do not participate in the huddle consistently to promote accountability. Provide the Chiefs of Surgery with weekly reports of FCS delays to increase their awareness of surgeons they supervise that did not participate in the huddles and had a delay. They are charged with counseling their surgeons to ensure that they improve with starting on-time. Additionally, these counseling sessions can be incorporated in the surgeon's annual performance exam. EC will also receive these weekly reports so that they can be kept abreast of the compliance with starting cases on-time and any barriers that the Chiefs of Surgery are experiencing. They can dedicate resources to support the efforts of the Chiefs of Surgery as they implement strategies to improve on-time starts while also holding them accountable for improving OR efficiency. Sixth, report the compliance with FCS, the reasons for any delays, and TOT to the Department of Surgery Committee so that there is a continued focus on improving OR efficiency. Seventh, have EVS leader review their staffing matrix to ensure adequate coverage, especially with multiple shorter cases that are scheduled in sequence, to maximize the number of cases that can be completed per OR suite on any given day.

Lessons Learned

Overall, this QI project successfully identified the reasons for delays with FCS while also establishing a mean TOT for each surgical service. In retrospect, there were lessons learned that could improve upon the project. A more comprehensive communication plan to all OR staff and EVS supervision to discuss the intent of the project, which staff member will be charged with collecting the data, and the criteria for determining delays with FCS and TOT would decrease any confusion with the data collection process. Therefore, the validity of the data would not come into question as it did. This would also eliminate the need for the nurses to assume the role of explaining the project to the surgeons in lieu of the Project Leader simply because they were more accessible. The Project Leader is intimately involved with the intricacies of the project which the nurses may not be able to relay to the surgeons thereby answering any concerns that surgeons may have. Any questions regarding the details of the project are to be directed to the Project Leader to ensure consistency in the messaging of the project's goals and objectives.

The communication plan that was carried out included meeting with the OR workgroup as well as the Department of Surgery Committee. This strategy relied heavily on the members of both groups to relay the project's goals and objectives to their colleagues prior to its implementation. It appeared that the nurses and anesthesiologists successfully communicated the project's details as they had fewer questions regarding their role whereas the surgeons had many more questions and concerns regarding the process. This organization is comprised of predominantly contracted surgeons that only perform surgery on given days of the week and some only once a month. This is challenging as the information may not reach all of the full-time staff and contracted surgeons, yet all of them were expected to participate in the huddles. An e-mail detailing the project and the expectations of the surgeons could have been sent to all surgeons followed by a letter from their respective Chief of Surgery to ensure that they were aware of the project's details.

Another strategy to address OR staff concerns would be to have the Project Leader shadow a patient from the pre-operative suite to the time they entered the OR suite. This would allow the Project Leader to immediately address any questions or concerns that the OR staff may have or correct any variances with how the data is collected. This will ensure that each discipline involved in the huddle is clear regarding their roles and responsibilities. As the project progresses and the OR staff is more comfortable with the process the Project Leader can present much more frequently at random times throughout the day to address any questions or concerns by the OR staff.

During the study period there were incidents in which all elements of the Surgical Start Time Log were not completed. This posed a challenge with data collection and analysis. As a result, the Project Leader presented to the OR in the morning to review the Surgical Start Time Logs that were completed the day before to ensure that all of the elements on the form were completed. If there were any questions regarding the data, then clarification from the nurse who completed the form was obtained in order to preserve the validity of the data. This practice of reviewing the data daily should have been implemented from the beginning of the data collection process to minimize missing data.

The practice that raised the most concern was publicly displaying Figure 6 in such a way that all of the OR staff was able to view it. This practice can be perceived as punitive which should not be the intent in a quality improvement project. The focus of the project should be one of collaboration and synergy to improve practice. As a result, future projects will not follow the organization's norm of publishing the names of specific surgeons and highlighting variances from what is expected practice. Therefore, the names of specific surgeons would not be displayed. Instead, the surgical service in which they belong or simply in the general term of surgeons one, surgeon two, surgeon three, and so on would be displayed. This may achieve the same results of generating accountability for improving starting cases on-time.

Conclusion

OR efficiency is closely tied to OR utilization. Delays with FCS combined with prolonged TOT can affect delays with the next scheduled case in the OR suite. The implementation of a pre-operative huddle showed a profound impact on decreasing delays with FCS. The majority of the delays with FCS are systems and process related, which are correctable, particularly surgeon tardiness. Taking a proactive approach to decrease delays with FCS can improve OR efficiency and save money.

REFERENCES

Arakelian, E., Gunningberg, L., & Larsson, J. (2008). Job satisfaction or production? How staff and leadership understand operating room efficiency: A qualitative study. *Acta Anaesthesiologica Scandinavica*, *52*, 1423-1428. doi:10.1111/j.1399-6576.2008.01781.x

Arakelian, E., Gunningberg, L., & Larsson, J. (2011). How operating room efficiency is understood in a surgical team: A qualitative study. *International Journal for Quality in Health Care: Journal of the International Society for Quality in Health Care*, *23*(1), 100-106.

Berwick, D. M. (1998). Developing and testing changes in delivery of care. *Annals of Internal Medicine*, *128*(8), 651-656.

Best, M., & Neuhauser, D. (2005). W. Edwards Deming: Father of quality management, patient, and composer. *Quality & Safety in Health Care*, *14*(4), 310-312.

Deming Institute. (n.d.). *The PDSA cycle.* Retrieved from https://www.deming.org/theman/theories/pdsacycle

Does, R., Vermaat, T., Verver, J., Bisgaard, S., & Heuvel, J. (2009). Reducing start time delays in operating rooms. *Journal of Quality Technology*, *41*(1), 95-109.

Ferrari, L. R., Micheli, A., Whiteley, C., Chazaro, R., & Zurakowski, D. (2011). Criteria for assessing operating room utilization in a free-standing children's hospital. *Pediatric Anesthesia*, *22*, 696-706. doi:10.1111/j.1460-9592.2011.03690.x

Guerriero, F., & Guido, R. (2011). Operational research in the management of the operating theatre: A survey. *Health Care Management Science*, *14*(1), 89-114. doi: 10.1007/s10729-010-9143-6

Heiser, R. (2013). Using a best-practice perioperative governance structure to implement better block scheduling. *Association of Operating Room Nurses, 97*(1), 125-131. http://dx.doi.org/10.1016/j.aorn.2012.10.007

Higgins, V. J. G., Bryant, M. J., Villanueva, E. V., & Kitto, S. C. (2011). Managing and avoiding delay in operating theatres: A qualitative, observational study. *Journal of Evaluation in Clinical Practice, 19*, 162-166.

Institute for Healthcare Improvement. (n.d.). *Science of improvement: How to improve.* Retrieved from http://www.ihi.org/resources/Pages/HowtoImprove/ ScienceofImprovementHowtoImprove.aspx

Li, D., Wang, S., & Powers, C. (2013). A systematic strategy for perioperative process improvement. *Proceedings of the Industrial and Systems Engineering Research Conference, Puerto Rico,* 626-634.

Masursky, D., Dexter, F., Isaacson, S., & Nussmeier, N. (2011). Surgeons' and anesthesiologists' perceptions of turnover times. *Anesthesia and Analgesia*, *112*(2), 440-444. doi: 10.1213/ANE.0b0133182043049

Meredith, J., Grove, A., Walley, P., Young, F., & Macintyre, M. (2011). Are we operating effectively? A lean analysis of operating theatre changeovers. *Operations Management Research, 4,* 89-98. doi: 10.1007/s12063-011-0054-6

Pandit, J., Abbott, T., Pandit, M., Kapila, A., & Abraham, R. (2012). Is “starting on time” useful (or useless) as a surrogate measure for “surgical theatre efficiency”? *Anaesthesia*, *67*(8), 823-832. doi: 10.1111/j1365-2044.2012.07160.x

Peters, J., & Dean, H. (2011). Enhancing or capacity and utilization. *Healthcare Financial Management: Journal of the Healthcare Financial Management Association*, *65*(1), 66-71.

Porta, C. R., Foster, A., Causey, M. W., Cordier, P., Ozbirn, R., Bolt, S., . . . Rush, R. (2013). Operating room efficiency improvement after implementation of a postoperative team assessment. *Journal of Surgical Research, 180,* 15-20. http://dx.doi.org/10.1016/j.jss.2012.12.004

Smith, C. D., Spackman, T., Brommer, K., Stewart, M. W., Vizzini, M., Frye, J., & Rupp, W. (2013). Re-engineering the operating room using variability methodology to improve health care value. *Journal of the American College of Surgeons, 216*(4), 559-568. http://dx.doi.org/10.1016/j.jamcollsurg.2012.112.046

Wolf, F. A., Way, L. W., & Stewart, L. (2010). The efficacy of medical team training: Improved team performance and decreased operation room delays. *Annals of Surgery*, *252(3)*, 477-483. doi:10.1097/SLA.0b013e3181flc091

Wright, J. G., Roche, A., & Khoury, A. E. (2010). Improving on-time surgical starts in an operating room. *Canadian Journal of Surgery, 53*(3), 167-170.

APPENDIX A

SURGICAL START TIME LOG

The circulating nursing staff was charged with documenting the time of the pre-operative huddle, participants (surgeon, anesthesiologist, pre-operative nurse, and circulating nurse), surgical service, any delays to FCS, scheduled FCS, and actual FCS.

Surgical Start Time Log

Date: / /
Pre-op Huddle Time: ____________ Participants: [ ] Surgeon [ ] Pre-op Nurse
[ ] Anesthesiologist [ ] Circulating Nurse
Surgical Service: __________________ Surgeon: ___________________________________
Scheduled Start Time: _____________ Time Patient in OR: __________________________

[ ] No Delay

[ ] Surgeon Delay
[ ] Anesthesia Delay
[ ] Pre-op Delay
[ ] Circulator Delay
[ ] Scrub Delay
[ ] Surgical Consent
[ ] Room Not Clean
[ ] Heart & Lung Documentation
[ ] History & Physical
[ ] Cardiac Clearance
[ ] Room Temperature/Humidity

[ ] Blood Consent
[ ] Equipment
[ ] Labs
[ ] EKG
[ ] MRI/X-ray
[ ] Pregnancy Test
[ ] Patient Arrived Late to Pre-op
[ ] Patient Condition Not Optimal for surgery
[ ] Other: _____________________

Completed by: _________________________

APPENDIX B

TABLE OF EVIDENCE FOR PROPOSAL

Summary of Studies for Operating Room Utilization

Purpose	Level of Evidence	Design, Sample, Setting	Methods	Results	Conclusions
Systematic approach to improve OR utilization & achieve system-wide optimization in surgical services (Li et al., 2013)	VI	Performance Improvement IV: block scheduling, TOT, on-time start DV: OR utilization 16 ORs in community hospital in Northeast Ohio	SSC (surgery dept chairman, surgical director, periop managers, director anesthesia, director process improvement dept) to lead/guide continuous improvement; voted block scheduling, TOT, & on-time start as most critical root cause for ↓utilization Lean Six Sigma Fishbone diagram ID 4 categories causing ↓utilization: people, process, policy, & equipment Dashboards to systematically review periop performance measures. Level 1 metrics: utilization, volume, TOT, & on-time start. Level 2 metrics: more detailed info of Level 1 metrics (i.e. utilization by day of week & room closure)	Block schedule: utilization ranged 27% to 94%; SSC removed block schedule if surgeon utilization below 65% → more open time on block schedule TOT (pt wheels out time to next pt wheels in time): ↑as day progresses; avg 29min; no clear & standardized process for turnover On-time start: impacted by delays of pt, equipment, surgeon, & nursing; not all delays can be avoided	Dashboard used to monitor process improvements; provide monthly reports for senior management, managers, & employees Lean Six Sigma can ensure improvements sustained; focus on root causes of problems Still in improvement phase; await control phase of monitoring & sustaining

Determine if changes in workflow could ↑utilization.
(Ferrari et al., 2011)
	IV	Quasi-experimental, time series design
		IV: OR utilization & TOT
		DV: OR efficiency
		27,851 procedures
			Operational hours = 0730-1700.
			Block time = # OR hours staffed & available for scheduling
			Utilization = in room time + OR TOT / all available staffed block time M-F each month
				Over 12 months, mean available time 4076 ± 319 hours/month & mean capped utilized time 3219 ± 300 hours/month. Average Capped TOT for 12 month period 616 ± 53	Utilization of block time one component of evaluating OR efficiency
					Efficient OR = max # procedures completed during staffed block time without

Purpose	Level of Evidence	Design, Sample, Setting	Methods	Results	Conclusions
		from general, orthopedic, GU, plastic, GYN, otolaryn-gology, & neurosurgery specialties. Children's Hospital Boston	TOT = min between "out of room time" & the following case "in room time" during scheduled block Capped TOT = time recorded when TOT > one hour Elective procedures scheduled electronically Block times assigned to each service. Unutilized block time returned to general pool & can be reserved on first come, first served basis Concurrent workflow changes: all physicians & nurses available 30 min before scheduled start time, actual on-time starts & TOT reported to OR staff	hours/month OR efficiency averaged 79% Utilization ratios ranged from 73% (February 2009) to 87% (July 2009) Turnover ratios ranged from 127% (November 2008) to 86% (June 2009) ↑ Efficiency ($p < .001$) beginning March 2009 with ↑utilization second half of fiscal year ↓turnover ratio ($p < .001$) beginning April 2009	overtime. ↑OR utilization: 1. Stagger nursing shifts to extend beyond block time 2. 80% utilization of block time by surgical service before more time allocated 3. Use capped TOT. Allocate TOT based on type of procedure 4. Emphasize starting on-time. Document reason for delay 5. Constant feedback of on-time starts & utilization of block time to staff
To use variability methodology to improve operational performance Hypothesis: by using operations management principles & variability theory, could expand OR capacity & ↑throughput without adding	IV	Prospective case study Manage flow of surgical patients into hospital & OR optimizing existing resources Scheduled & unscheduled cases competing for same resources. Elective or urgent/emergent Mayo Clinic, Jacksonville, Florida	Variability theory defines two types variation: natural (controllable) & artificial (uncontrollable) Principles: (a) Mixing scheduled & unscheduled flow streams/resources lead to unpredictability & unnecessary variability (b)Variability methodology using math modeling can produce predictable day-to-day schedule Prime time = 0730-1700 M-F Urgent/emergent = cast must be performed within 24 hours for	One year after redesign: Surgical cases ↑4% Surgical min ↑5% Prime time OR use ↑5% Average # OT ↓27% Staff turnover rate ↓43% Daily case volume variation ↓20% Daily case min variation ↓22% Daily elective room changes, average/month	Variability methodology aims to manage flow of patient into OR & surgical services rather than through ORs; isolate scheduled from unscheduled cases; smooth out weekly volumes; allocate resources for unscheduled cases Culture change from what is best for surgeon to what is best for hospital Before applying variability methodology, assess hospital's culture, providers, &

Purpose	Level of Evidence	Design, Sample, Setting	Methods	Results	Conclusions
infrastructure or expense (Smith et al., 2013)			clinical reasons Data collection 3 months without changes to OR workflow. Then, redesign of OR Design team = management team	↓69% Daily elective room changes ↓70% Cost/minute of surgery ↑1% Staff turnover cost ↓43% Total OR revenue ↑5% Net operating income ↑38% Net operating margin ↑38% Schedule predictability →Greater throughput w/o additional resources	willingness to change Support hypothesis that more surgeries can be performed without increasing cost
Effect of perioperative governance structure with OR scheduling (Heiser, 2013)	VII	Effective scheduling program → ↑surgeon productivity & revenue, efficient facility use, ↓cost/surgery, ↑nursing & anesthesia productivity & morale	Periop governance structure function as “board of directors” for periop program charged with establishing accountability, improve OR processes, & discipline staff	Establish consequences for late starts (e.g. move cases later in day) Ideal OR EC = OR director, surgery dept medical director, representative from senior administration • Market surgical program • Ensure program meets pt’s & surgeon’s needs • ↑procedure volume revenue • Develop surgery	Effective block scheduling requires periop governance structure to ↑efficiency OR EC working closely w/ surgery director & OR advisory committee Mix block, open, & urgent time improves OR use & adapts to changes in surgical volume

Purpose	Level of Evidence	Design, Sample, Setting	Methods	Results	Conclusions
				medical staff & strategic plans OR Advisory Committee = surgery dept chairs, anesthesia manager, & administrator over OR; primary responsibility communicating with medical staff Block schedules preference to surgeons with high financial contribution	
To ↑OR utilization—facility space & staffing—by establishing surgery EC to strengthen performance improvement efforts (Peters & Dean, 2011)	IV	Case Study Baptist Health Medical Center-North Little Rock; 220 bed hospital; Little Rock, AK Hospital leaders investigate ways to improve utilization with current resources	Created surgical services EC (6 surgeons, 1 anesthesiologist); good working relationship w/ hospital administration & influential w/ medical staff EC met monthly to discuss OR metrics: FCS & TOT	4 hour blocks cannot accommodate multiple procedures New schedule of 8 hour blocks 75% utilization needed to keep block times Preop process: TC to pt for short interview re: meds & med Hx; based on answers pt is triaged for preop AM huddle by surgery director, OR nurse supervisor, & preop supervisor to review cases in next 5-7 days to ensure pt w/o medical issues	Improved efficiencies in processes & surgeon maximizing their block time led to increased utilization from 61% to 68% New OR block schedule spread surgical cases out during week

Purpose	Level of Evidence	Design, Sample, Setting	Methods	Results	Conclusions
				before surgery Preop process & AM huddle improved case pipeline & better pt care Block utilization ↑ from 61% to 68% by maximizing block time, preop process, & Am huddle; ↓overtime & call expenses	
Structured literature review to learn how Operational Research can be used for surgical planning & scheduling. (Guerriero & Guido, 2011)	VI	Structured literature review explore how Operational Research improve OR management Operational research = scientific approach to problem solving	Reviewed papers that used math models & simulation strategies to solve problems w/ OR management 48 papers reviewed	Late starts→overtime Open, block, modified block scheduling; block most common Hierarchical decision levels: 1. Strategic: distribute OR time among different SGs 2. Tactical: develop MSS once OR time allocated to each SG 3. Operational: schedule elective cases daily, after MSS developed "Easily" handle surgery schedule problem by 1. Pt selection 2. Pt assignment to surgical service 3. Determine surgery date & OR	Balance surgical costs with providing high quality patient care Planning & scheduling affect OR & impacts productivity of OR staff Operational Research goals: 1. ↑ pt throughput 2. Improve satisfaction of pt, surgeons, & OR staffs 3. Max utilization of OT resources 4. ↓ cancellations 5. ↓ late starts & TOT

Note. OR = Operating Room; min = minutes; IV = independent variable; DV = dependent variable; IRB = Institutional Review Board; GU = genitourinary; GYN = gynecology; CR = cancellation rate; FCS = first case start; TOT = turnover time; OT = overtime; stat = statistics; pt = patient; freq = frequent; preop = preoperative; periop = perioperative; dept = department; EC = executive committee; TC = telephone call; med = medication; Hx = history; OT = operating theater; SG = surgical group; MSS = master surgical schedule; ID = identified; SSC = surgical services committee; avg = average.

Summary of Studies for Operating Room Efficiency

Purpose	Level of Evidence	Design, Sample, Setting	Methods	Results	Conclusions
To determine causes of OR delays in standardized post-op assessment Hypothesis: standardized post-op assessment will help improve overall OR efficiency (Porta et al., 2013)	IV	Single center prospective observational study IV: post-op team debriefing DV: OR utilization & efficiency Analyzed 11,342 OR procedures for Utilization & efficiency (January 2010 to December 2010) at Madigan Army Medical Center in Tacoma, Washington 1.3 million min OR time 2800 total delays = 48,386 min	Delays measured by electronic case scheduling system & post-op debrief At end of operations, debriefing to categorize delays, give qualitative/ quantitative data that contributed to delay. Electronic debriefing form (delays along with plans for improvement) completed by OR nurse. OR utilization management develop/implement corrective action plans One day tutorial & training regarding debriefing process provided to staff	Average OR delay 17.3 min Longest delays due to: 1. Radiology (*M* = 40 min) 2. Patient flow—not arriving on time, pre-op issues (22.9 min) 3. OR supplies (22.7 min) 4. Surgeon (18 min) 5. Nursing (14 min) 6. Room turnover (14 min) Average delay ↓ 18.9 to 15.2 min in 12 months ↓39% in un-utilized available OR time due to delays, OR efficiency ↑2334 min (212 min/month) Compliance with completing debriefing form ↑ 70% to 90%, % cases scheduled appropriately ↑ 94.3 to 98.6 over 1 year	Standard debrief process minimizes OR delays, particularly in larger hospitals with a larger multidisciplinary staff Electronic debrief form can be completed in one or two min After implementation of debrief process, mean delays ↓ 9%, ↓ waste 39%, gaining 212 min of OR time per month Overall # of delays ↓ by 10.8 days per month Gains still does not equal additional case per day, but will help with over-utilization to bring down cost of overtime
To explore sources of delay that may impact manner in which staff deal w/ & avoid	IV	Qualitative, observational study Study from a larger study about communication failure in OR. Study focused on team	Through observation determined patterns of behavior Observations of surgeries ranged from 20 min to almost 4 hours Primary observations about use of	Delays in 13/30 observations (11 in metropolitan hospital, 2 in regional hospital) Nature of delays: Communication errors,	Delays vary in severity & some cannot be resolved with checklists Delays ↓ OR efficiency Medical staff integral in

Purpose	Level of Evidence	Design, Sample, Setting	Methods	Results	Conclusions
delays (Higgins et al., 2011)		communication & reporting 30 surgeries from a metropolitan & a regional hospital in Australia	time & timing in OR	delay in previous procedure, patient condition, resources not available, surgeon unavailable Themes: 1. Challenges in addressing OR delays: a) unanticipated changes in patient condition & hierarchical relations b) late surgeons 2. Averting & anticipating delays: a) differences in professional power, status & authority b) anticipating end of current surgery & when to call for next patient	managing & avoiding delays Strategies to avoid delays should focus on building/working on existing work practices & professional hierarchies
To evaluate an initiative to improve the # of on-time starts in OR (Wright et al., 2010)	IV	Performance Improvement-- multi-disciplinary task force addressing on-time starts Data collected for patients in room by 0815; determine how often cases start on-time; document delays Pre-project, patients in room by 0800 5%-7%; by 0815 70%-75%	Chief of Surgery prioritized improving efficiency, safety, & quality & discussed with staff at 1 day retreat focused on: 1. Positive encouragement 2. Team approach (identified first efficiency initiative as on-time starts because involved nursing, surgery, & anesthesia) 3. Identified concern with safety & quality Used Kotter's 8 steps to transforming	Delays in on-time starts mostly due to: anesthesiology availability (24%), surgeon availability (21%), missing blood work/pre-op sedation Initiatives implemented to ↓ barriers to on-time starts: 1. Staff to pre-op area by 0715	Focus on positive reinforcement to enhance sense of team Stepwise & collaborative approach Despite resistance from surgeons & anesthesiologists about 0735 huddle, single most effective strategy for improving on-time starts

Purpose	Level of Evidence	Design, Sample, Setting	Methods	Results	Conclusions
		Level 1 trauma center OR Peds hospital in metropolitan Toronto, Ontario	organizations: OR task force met monthly to develop/implement strategies to improve start times of 0800 (time pt in OR suite)	2. Electronic charts in each OR for anesthesiology access 3. Pre-surgical anesthesia clinic in one location 0735 huddle to discuss cases for day had most significant impact to starting on-time Did not achieve on-time start target of 90%, but improved from 6% to 60%	Starting on-time gained 15 min, but still cannot add cases to end of day
To determine the efficacy of MTT on team performance & OR delays (Wolf et al., 2010)	IV	Quantitative, observational study. IV: MTT DV: Team performance & OR delays 4863 OR briefing/ Debriefing encounters between September 2006 & August 2008 8 ORs at SFVAMC	One day MTT interactive learning session: all OR staff attended; didactic modules, videos, & role playing Briefing/debriefing protocol to prioritize issues to be addressed by MTT EC MTT EC met regularly to ensure project sustainability & address issues Pre/Post design assessed safety culture via anonymous questionnaire (SAQ). Delays evaluated 1 year pre & post project implementation	MTT compliance rates 95%-100% for all surgical sections SAQ scores improved in all domains: perceptions of management (p = .003), working conditions (p = .004) Case delays ↓ from 32% to 19% pre/post 11-14 months after implementation, $p < .05$: any delay, preop delay, nursing delay, equipment issue, equipment not available, equipment malfunction, hand-off issues, mean # issues requiring follow-up	Positive impact of EC MTT process not complicated Expedited responses from EC regarding issues identified on briefing/debriefing checklist

Purpose	Level of Evidence	Design, Sample, Setting	Methods	Results	Conclusions
				22-24 months after implementation, $p < .05$: any delay, surgeon delay, anesthesia delay, & mean # issues requiring follow-up	
To explore the variations in how OR staff & leadership understand & experience OR efficiency in reaction to demands for ↑efficiency at work (Arakelian et al., 2008)	VI	Qualitative study using Phenomenology 21 staff, 4 males & 17 females Mean age of 48 (range 33-68) Staff experience 10 months to 41 years OR department in a Swedish county hospital	Semi-structured interviews; 20-66 min. Tape recorded & transcribed Questions: 1. What do you think about when I say “workflow?” 2. What do you think about when I say “obstacles?” 3. What does the word “efficiency” or “being efficient” mean to you? (p. 1424) Data Analysis: 1. Transcripts read through. 2. Significant utterances about efficiency identified. 3. Utterances compared to find patterns. 4. Categories were formulated & named Responses categorized into themes.	Categories regarding how OR efficiency understood: 1. Individual knowledge & experience 2. Job satisfaction 3. Work process. 4. Right tasks to be completed 5. Work assignment 6. Production per time unit (p. 1425) Nurses, assistant nurses emphasized 1 & 3, while supervisors, surgeons, & anesthesiologists emphasized 5 & 6	Staff understood OR efficiency in terms of individual competence while leadership understood it in terms of production Work process (categories 1 & 2) can lead to smooth patient flow (categories 3 & 4), which can lead to completing the work & improved production (categories 5 & 6) Literature lacking in understanding OR efficiency. More is needed to ensure that staff & leadership are working collaboratively to achieve same goals
To study how OR efficiency understood by surgical team members & their leaders (Arakelian, et	VI	Qualitative study using Phenomenology 11 participants (9 members on same team & 2 leaders) 1100 bed Swedish university hospital with 6	Team members worked only w/ patients undergoing specific type abdominal surgery; cared for patients during entire periop period Scheduled 2 patients/week Interviews w/ open-ended questions & probing questions; 28 – 65 min	7 ways of understanding OR efficiency 1. Do your best to achieve good workflow 2. Be adaptable to different situations 3. Collaborate w/ other team members & work	1-3 focus on individual control regarding ↑efficiency 4-6 focus on organization needs to ↑efficiency Pt care central theme in

Purpose	Level of Evidence	Design, Sample, Setting	Methods	Results	Conclusions
al., 2011)		operating departments Team members worked together 1.5–2years; between 36–62 years old; work experience 1.5–33 years	long; tape recorded; transcribed verbatim 3 questions: "work flow," "obstacles & hassles" and 'efficiency or being efficient' meaning to participants	to your capacity 4. Achieve desired results w/o ↑resources 5. Provide high quality care while accomplishing tasks quickly 6. Invest resources to achieve long-term gains for pt health 7. Efficiency achieved w/ experience & resources available	↑efficiency
Hypothesis: start time important metric of OR efficiency Late start → end late & ↓efficiency (Pandit et al., 2012)	IV	Descriptive correlational study > 7000 theatre lists from 2 similar UK hospitals Hospital A: 22 operating theatres Hospital B: 12 operating theatres	Data collected from automated system (all elective, general surgeries, but no emergency surgeries) Documented scheduled start time, actual start time, length of surgery, under & over-run times, gap time, # cases scheduled, & # cases completed Calculated efficiency of each above No comparisons between 2 hospitals, but start & finish time using Pearson's correlation	Start time not good predictor of efficiency Hospital A (r^2 = .014) Hospital B (r^2 = .3)	Start & end time poorly correlated at both hospitals (r^2 = .077 & .043) Use of on-time start as a metric for productivity not associated with OR efficiency Developing proper OR schedule that calculates finish time would be better metric for OR efficiency A fixed start time not only measure that can be explored to determine improved OR efficiency & utilization
Application of Six Sigma to improve OR efficiency	IV	Case study Quality improvement project using Six Sigma	Each OR & 1st operation, recorded, 1. Official start time 2. Time of arrival 3. Time of arrival in OR of 1st pt.	Avg delay start time 35 min & 25 min at RCH & CHW, respectively Poor planning &	Six Sigma helpful in problem solving processes Both hospitals saved money by ↓delay in start times;

Purpose	Level of Evidence	Design, Sample, Setting	Methods	Results	Conclusions
(Does et al., 2009)		Red Cross Hospital in Beverwijk, Netherlands; 9 ORs; 384-bed hospital Canisius Wilhemina Hospital in Nijmegen, Netherlands; 13 ORs; 653 bed hospital	4. Time anesthesia starts 5. Time incision starts 6. Time surgery ends 7. Time pt leaves OR 8. Anesthesia technique 9. Specialty	scheduling process most important factor in delay to start times--Unclear time pt to arrive at admission, time to start premedication, time anesthesiologist should be available New planning process • Pt arrive to OR no later than 0735 (RCH) & 0800 (CWH) • Pt receive preop med before arrival to OR • Referring dept & anesthesiologist informed 1 day in advance of scheduled procedure New process ↓delay 25% at RCH & ↓ > 30% at CWH	↓cost while ↑quality CWH able to ↑ # operations by 10% w/o additional resources

Note. OR = Operating Room; min = minutes; post-op = postoperative; pre-op = preoperative; IV = independent variable; DV = dependent variable; Peds = Pediatric; Periop = Perioperative; pre-op = Preoperative; post-op; MTT = medical team training; SFVAMC = San Francisco Veterans Administration Medical Center; EC = Executive Committee; QA = quality assurance; SPD = Sterilization, Preparation, & Distribution; SAQ = Safety Attitudes Questionnaire; CTQ = Critical to Quality; RCH = Red Cross Hospital; CHW = Canisius Wilhemina Hospital.

Summary of Studies for Operating Room Turnover

Purpose	Level of Evidence	Design, Sample, Setting	Methods	Results	Conclusions
To identify key factors that impact TOT between surgeries (Meredith et al., 2011)	IV	Observational study 5 hospitals (2 UK, Finland, Sweden, & Australia) Observed 29 days of elective orthopaedic surgery; about 232 hours; analyzed by 2 independent observers	TOT as measure of utilization because contains all activity save actual surgery TOT defined as last stitch of pt in OR to incision of next pt Video analysis: ↓observer bias	Variation in mean first case setup & changeover times evident (range 45-110 & 56-75, respectively) Trend implies longer first case setup negatively correlated w/ shorter changeovers Critical phases in changeover process 1. Pt removal 2. Pt transition--cleaning 3. Operation prep--next pt White space = time w/o activity (waiting for personnel, pt, or instruments); most common between cleaning, instrument prep, leg prep, & incision Surgeon availability before required→↑teamwork, ↓delays	Surgery analogous to mass production line To maximize effectiveness: • Simplify, standardize, & minimize 3 phases in changeover process • Concurrent processing requires less time than series processing • Eliminate white space to ↓changeover time • Long first care setups related to shorter changeovers • Surgeons in OR before required ↓instrument setup & motivational factor for OR staff
Perception of TOs may be influenced less by actual TOT than perception of how team activity influences TOT	IV	Survey of 78 subjects (surgeons & anesthesia staff) at SUNY Upstate University Hospital (U.S. academic hospital) Surgeons' estimates of TOT > anesthesiologists	Some completed paper survey; some interviewed Subjects can include qualitative comments that were transcribed & classified into thematic categories Prolonged TOT = > 45min Excluded "very few" TOs (< 4 TOs	# comments about TOs not proportional to total waiting time experienced 1100 to 1300 w/ many prolonged TOs > 79% surveyed thought TOs at least 2 hours longer	Many surgeons overestimate TOTs & markedly overestimate incidence of prolonged TOs Recommend OR managers consider team activity& attitude about facility rather than fixate on time when

Purpose	Level of Evidence	Design, Sample, Setting	Methods	Results	Conclusions
(Masursky et al., 2011).		estimates (p = 0.002) Recommend OR managers consider team activity& attitude about facility rather than fixate on time when discussing TOT.	≤ 90min for each of 6 2-month periods).	than actual (p < 0.0001) Surgeons' estimates of TOT > anesthesiologists estimates (p = 0.002).	discussing TOT.

Note. UK = United Kingdom; pt = patient; prep = preparation; TOT = turnover time; TO = turnover; min = minutes.