Creating an Efficient Operating Room

by

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Abstract

The cost of healthcare in the United States continues to increase exponentially, while at the same time reimbursement rates continue to decrease. Now more than ever it is vital for hospitals to find ways to improve quality while at the same time decreasing costs. Operating rooms are a fertile ground to test the powerful potentials of this strategy, as they are at once the most lucrative areas in hospitals, and also the most inefficient and costly (Cerfolio et. al., 2019). There are multiple metrics at the root of operating room inefficiencies, and only a thorough understanding of those metrics can guide the choice of the interventions needed for improvement. There are also multiple different proven interventions that can be used to improve operating room efficiency ranging broadly in both scope and scale. Recently, an academic hospital in Pittsburgh implemented a project looking into reasons behind longer operating room turnover time. The project uncovered numerous inefficiencies in operating room procedures and processes like excessive holding time and pre-operative time, procedure add-ons, transport, room delays, surgeon delays, direct ICU hand off, staffing, and room staggered. Identifying inefficiencies creates opportunities for improvement through a variety of initiatives both small and large. This research paper outlines different metrics associate with intra-operative and pre-operative inefficiencies and different interventions that can streamline processes.

TABLE OF CONTENTS

List of Figures

List of Tables

1.0 Introduction

There are two general trends in the healthcare marketplace— a decrease in reimbursement for procedures and increases in the cost of care— that are making it harder than ever before for health systems to meet their bottom line. It is vital that health systems find ways to decrease costs. In 2019 the United States health care spending was $3.8 trillion, or $11,582 per person, an increase of 4.6% from the previous year ("National health", 2020). To decrease healthcare spending, government and private insurers pay health care systems based on value-based payments, diagnosed related groups (DRG), and bundled payments ("What are", 2020; "Bundled payments", 2016). The Center for Medicare and Medicaid (CMS) recommends these payment methods to drive and improve care quality, which will decrease costs ("What are", 2020). Health care systems must focus on improving efficiency to meet the growing demand for high-quality, low-cost health care to maintain sustainability and maintain profit margins.

Efficient use of operating rooms (OR) is one method that health systems can use to decrease costs. OR's have both favorable and unfavorable consequences; they are the money makers accounting for up to 60-70% of revenue and yet, ORs are the most expensive hospital department accounting for 40% of overhead costs (Rothstein & Raval, 2018). On top of the financial savings of an efficient OR, there are other cascading benefits such as improved patient safety, increased OR throughput, and improved patient, physician, and staff satisfaction (Rothstein & Raval, 2018). These secondary benefits allow for an improved workplace culture which, in turn, motivates staff and physicians to continue improving efficiency.

The operating room is a complex environment with multiple stakeholders, including physicians, nurses, anesthesiologists, Certified Registered Nurse Anesthetists (CRNA), patients, environmental services (EVS) staff, and OR front desk staff. If one worker doesn't show up for

work, is late, or is at home sick, it throws the OR off its axis by pushing back case start times or the canceling of cases. Poor communication between stakeholders can negatively affect the OR as well. If a staff member goes on a lunch break or gets pulled away from the OR to do another task, they often don't communicate, which can cause standstill time in the OR (Lee et al., 2019). Every patient that goes into the OR has different comorbidities. The differences in patient profiles means that while two patients may be having the same procedure, one could take longer than the other because of complications. A physician could block out the same amount of time for both procedures, but one might run overtime because of difficulties. System factors such as supplies, central sterile, transport, and the effective planning and scheduling of OR block time also play a role in the OR's complexity (Lee et al., 2019). All of which makes improving OR processes challenging but certainly not impossible.

Effective quality improvement initiatives using Lean and Six-Sigma approaches have been aimed at enhancing workplace culture and streamlining communication to help improve OR efficiency. These interventions range from short to long-term projects like facilitating communication, culture improvement, and complete process improvement initiatives. There are a variety of methods to create change in the OR to maximize efficiency. A process improvement initiative was executed at the University of Pittsburgh Medical Center (UPMC) Presbyterian Hospital, in Pittsburgh Pennsylvania, investigating extensive OR turnover times within the trauma service line. Several communication interventions were implemented to decrease the gap between actual and expected turnover time. This paper will outline the observed root causes of OR inefficiencies, describe opportunities to reduce inefficiencies, and recommend strategies that this hospital and others can use to improve turnover time in the OR.

2.0 Preoperative Metrics Causing OR Inefficiencies

The complexity of the OR is associated with multiple factors that can contribute to varying and sometimes uncertain outcomes. In some cases, the patient reacts unexpectedly, or the procedure takes longer than anticipated. That is why it is hard to identify intra-operative metrics that are causing inefficiencies in the OR. However, multiple pre-operative metrics contribute to creating inefficiencies throughout the process. Recognizing these metrics can have substantial cost savings. Depending on the procedure type and length, the cost to run an OR ranges between $30-$100 per minute, which is why maximizing operating room efficiency is imperative (Lee et al., 2019). Defining these metrics is the first step in the process of improving OR efficiency to reduce cost.

2.1 First Case On-time Starts

The first case sets the day up for success— if the first case isn't on time, the potential is great for all following cases to be delayed as well. Factors that cause late first case starts include physicians or staff arriving late, a patient arriving to the hospital late, transport issues within the hospital, or last-minute changes in the OR schedule.

2.2 Procedure Cancellation or Delay

The cancelation of procedures can push case start times back, in the process turning what would have been productive OR hours into nonproductive OR staff time (Vassell, 2016). In some cases, canceling a procedure is not preventable— for instance, if a patient isn't stable enough for surgery, it is in the patient's best interest to cancel the procedure. However, 50-70% of OR cancelations are preventable (Lee et al., 2019). There are many factors associated with procedure cancelations; a few that top the list include prioritizing emergent cases, lack of hospital bed capacity, patient no-shows for procedures, patients missing preoperative screenings, and the availability of required OR staff (Lee et al., 2019). Cancellations related to patient no-shows,

missing preoperative screenings, and limited hospital bed capacity can be prevented with proper planning and processes.

2.3 Cases Appropriately Scheduled

The accuracy of procedure duration is critical to running an efficient OR. When a procedure time is overestimated, it causes OR underutilization, translating into missed opportunities to increase revenue. If procedure time is underestimated, it can push back the OR closure time, leading to several bad outcomes— an increase in overtime costs, case cancelations (lost revenue), and decreased patient satisfaction (Lee et al.,2019). Physicians and all OR staff need to manage OR staff, supplies, and procedures to ensure the schedule is put together accurately and cases are moving along on-time. This involves constant communication with the OR front desk, making sure that the schedule is correct the day before surgery and if a procedure is taking longer or shorter than anticipated, ensuring the OR nurse calls the front desk to keep them updated.

2.4 Operating Room Turnover Time

Turnover time is defined as the time from when the previous patient leaves an OR to when the next patient enters the same OR. A term that is used to describe turnover time is "wheels out to wheels in." There are many moving parts during the time between cases, from EVS workers cleaning and sterilizing the room for the next case to the necessary supplies being assembled to prepare for the next case (Vassell, 2016). Multiple factors can prolong turnover, including delayed transport, extended holding time, Post Anesthesia Care Unit (PACU) availability, and inefficient patient hand-off. Extended turnover time can push back case start times, leading to the cancelation of later procedures resulting in decreased revenue, increased overtime staffing costs, and reduced patient satisfaction (Lee et al.,2019).

2.5 Appropriate Staffing

Staffing in the OR is a difficult task — the OR director and managers need to make sure that there is enough staff to cover unexpected urgent cases coming into the OR or cases that go over their block time (Lee et al.,2019). It is key that the OR is appropriately staffed to meet patient needs, however, unpredictable factors like emergent cases and cancelations can unravel the best-planned schedule. Understaffing can put patients at risk, whereas overstaffing can hurt financial performance due to staff underutilization. Overstaffing and understaffing can also cause a decrease in employee satisfaction should staff get sent home early or are told not to come in or get a call on their day off to come in. OR leadership must find a happy staffing medium to improve and maintain OR efficiency.

3.0 Intra-operative Metrics Causing OR Inefficiencies

There are two key intra-operative metrics that can contribute to OR inefficiencies that respond well to standardization— physician preference cards and composition of surgical team.

3.1 Standardizing Physician Preference Cards

Physician preference cards outline a list of supplies that a surgeon requires to perform a procedure successfully. These essential documents help hospital staff prepare for a procedure; however, they can cause inefficiencies in the OR if they are not continually updated or standardized. These cards are the basis of the supplies inventoried for each procedure. Preference cards can directly drive OR supply expenses with resulting in negative consequences. For example, two surgeons from the same specialty, both performing the same procedure, might have two drastically different preference cards, with different required supplies and materials for the same procedure creating variation in the average cost per case (Geppert et al., 2018). Two surgeons doing a hernia repair might each use a different mesh to strengthen the abdominal wall, yet neither has an added benefit over the other. The real difference between the two is cost— one mesh costs $35, and the other $100. Since there is no clinical benefit to using one over the other, the surgeon using the more expensive mesh costs the hospital an extra $65 per hernia repair, which comes right off the bottom line. However, in some instances, different equipment or supplies is necessary because of the patient's needs. In those cases, using the proper equipment that has the patients' best interest in mind is the right option.

A different problem can occur when the preference card is out of date, meaning that there are supplies on the card that are picked but not used during the procedure. The variation in supplies inventoried from surgeon to surgeon creates an opportunity to decrease surgical supplies costs. Standardizing preference cards have been proven to reduce OR expenses significantly. A study

done at Massachusetts General Hospital (MGH) to lower supply costs in General Surgery found a savings of $21,650 per year in supplies cost for Laparoscopic Cholecystectomies alone. It was estimated that if MGH replicated this cost-saving initiative across their whole general surgery department, these savings might be as high as $750,000 (Geppert et al., 2018).

3.2 Standardizing Surgical Teams

The use of standardized surgical teams in the operating room can increase operating room efficiency by decreasing operative time. Multiple studies have found that standardized surgical teams can reduce operative times by 9 to 47 minutes (Lee et al.,2019). A study done by Xu et al. 2013 explored the effect team familiarity has on improving operative time. The study looked at 754 mammaplasty procedures performed by 223 teams consisting of 8 attendings and 107 assisting surgeons. Next, they looked into the number of previous collaborations ranging from 0-18. The research demonstrates two significant findings noting that greater cooperation between attending and assisting surgeons had a substantial impact on operative time reduction and that the more surgical teams worked together, the more operative times decreased. When surgical teams are formed, relationships are built, and team members can anticipate others' actions resulting in greater trust between members. Increased collaboration between surgical staff is proven to help decrease operative time, resulting in improved OR efficiency. However, a plateau in inefficiency is eventually reached, as any team can be only so efficient during each procedure (Xu et al., 2013).

4.0 Metrics Effecting UPMC Presbyterian OR

Based on the preoperative and intra-operative metrics explained previously, Table 1. outlines the metrics uncovered during the UPMC Presbyterian improvement project cause inefficiencies in the OR. The project found that four out of five preoperative metrics and one out of the two intra-operative metrics affected the trauma service lines OR efficiency. The reasons behind why and how these metrics were affecting the Presbyterian trauma service line are explained in section six.

TABLE 1: METRICS EFFECTING THE UPMC PRESBYTERIAN OR

Preoperative Metrics	
First Case On-time Starts	
Procedure Cancelation or Delay	
Case Appropriately Scheduled	
Operative Room Turnover Time	
Excess Staffing	
Intra-operative Metrics	
Standardizing Physician Preference Cards	

5.0 Patient and Employee Satisfaction

An inefficient OR doesn't just affect the hospital's finances; it can have cascading effects on patient and employee satisfaction. One of the quality measures of the CMS value-based purchasing program is patient satisfaction. Patient satisfaction is measured by the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS), a publicly reported patient perspective survey intended to create transparency between health care consumers and providers ("HCAHPS", 2020). The HCAHPS score is a measure of patient satisfaction for the CMS Value-Based-Purchasing payment program. OR efficiency is tied to HCAHPS because pushing back patients' procedures results in patients waiting hours to have a procedure or getting their procedure canceling. Both scenarios result in unmet expectations, which may lower patient satisfaction and HCAHPS scores, translating into lower reimbursement (Vassell, 2016).

Inefficiencies in the OR can also cause a decline in *employee* satisfaction. The OR is an unpredictable high-stress work environment; one mistake can put a patient's life at risk. When the OR is running behind because the schedule was overbooked or the first case on-time start was late, it puts stress on staff and can force them to work overtime. In addition, if necessary, supplies are missing while the patient is on the table, the staff has to rush around needlessly to find them, all the while putting patients' lives at risk. These two examples are a small sampling of the stressful situations that can be eliminated if the OR is efficiently run. Streamline processes improve patient satisfaction and create a better work environment for staff, thereby increasing job satisfaction (Cima et. al., 2011).

6.0 Interventions

The interventions used to create an efficient OR environment depend on the metrics associated with the inefficiencies. Multiple interventions are proven to improve OR efficiency—including cultural changes, streamlined communication, transparency, and use of Six Sigma and Lean approaches. These interventions create change, improve processes, and increase communication by working with all OR stakeholders.

6.1 Cultural Changes

Cultural changes in an organization can significantly impact creating a more positive work environment, improving patient satisfaction, and employee engagement. Culture in this context is defined as "the beliefs, values, and behavioral norms shared between individuals in a team or unit" (Sacks et. al., 2015, p.458-59). Each OR's culture is different and relies heavily on the provider and specialty, meaning that the broader organization's culture can be completely different from what is seen in the OR specifically. Success in culture improvement in the OR occurs when organizations tailor their initiatives to the specific OR sites. Hence, when trying to change an OR culture, it is crucial to fully understand the specialty and the surgeon(s) performing the procedures. Since there can be vast differences between OR cultures, there can be no one size fits all culture improvement strategy. Operating rooms are multidimensional, with various provider groups, including surgeons, nurses, and anesthesiologists. There is also a hierarchy in the OR between attendings, fellows, med-students, and non-surgical staff. This embedded institutional culture can make it hard to create change, but organizations can succeed with a multimodal approach. This approach involves administrative leadership driving the initiative and including all pertinent stakeholders in initiatives designed to improve workplace culture.

Culture improvement interventions can be grouped into three different categories -- teamwork, communication, and safety climate (Halim et. al., 2018). Teamwork is enhanced with regular communication between team members when there are 5-minute briefings and debriefings of the surgical team before and after each operation to review each case. Morning huddles serve as general daily meetings of all OR staff during which physicians can identify goals and possible delays for the day (Halim et. al., 2018). These quick reviews can prevent avoidable surprises and set up teams for success.

Within the Team-work category are two types of regular meetings 5-minute briefings and debriefings of the surgical team before and after each operation to review each case. These 5-minute meetings can increase communication and build teamwork between members of the surgical team. Morning huddles serve as general daily meetings of all OR staff during which physicians can identify goals and possible delays for the day (Halim et. al., 2018). These quick reviews can prevent avoidable surprises and set up teams for success.

Effective communication strategies include educational programs ranging from a single 20-minute online educational video to multiple-day classes. The education approach depends on the OR team's needs, and most programs are developed by an improvement specialist alongside the medical staff. Checklists can be used to improve communication and safety "by standardizing processes, streamlining care pathways, and empowering team members to speak up when care deviates from expected (Sacks et. al., 2015 p.463). An example of a checklist used at multiple organizations throughout the United States is the WHO Surgical Safety Checklist; however, many organizations prefer to create their own and tailor them to their specific operations (Sacks et. al., 2015). Most culture improvement initiatives use a combination of effective team meetings, education, and checklist to create lasting cultural change in the and improve overall efficiency (Sacks et. al., 2015).

Culture improvement is directly tied to improvement in employee job satisfaction. A systematic review on interventions to improve surgical culture found that the implementation of cultural initiatives improved staff's perception of management and working conditions (Sacks et al, 2015). Improvement in job satisfaction translates to increased employee retention and reduced turnover, which is tied to decreased employee training costs without the endless flow of new personnel. In addition, this research study found that culture change resulted in first case on-time starts improving from 69% pre-intervention to 89% post-intervention. Sacks et al. (2015) also found that organizations that implemented culture change saw decreased OR delays, improved equipment availability, and reduced patient handoff problems. These small and low-cost improvements in culture can improve OR efficiency incrementally, adding up to large financial and employee engagement gains. However, it is important to note that one organization's success with culture improvement does not necessarily lead to success in another organization. Culture improvement initiatives take time, and leadership's persistence with initiatives will reap significant rewards in the future (Bender et al., 2015).

6.2 Transparency and Incentives

Transparency between leadership and OR staff can also help decrease costs in the OR. In some instances, surgeons and OR staff are not aware of the cascading expenses of being 10 minutes late arriving in the OR or the impact of canceled cases. Educating surgeons and staff about the cost of OR delays or different supplies can persuade them to change behaviors (Fong et al., 2016). In the previously stated example regarding the choice of surgical mesh for hernia repairs, the surgeon may be unaware of the cost differences between different products, leading to significant cost savings. Data transparency can also help improve efficiency in the OR by providing stakeholders with assessments related to their performance (Fong et. al., 2016). It can also provide evidence to

stakeholders to leverage their help with improvement initiatives. For example, the Vice President of Operations may receive monthly reports outlining the causes of all delays in the OR and regularly use this information to inform stakeholders on how well or poorly they are performing (Halim et al., 2018). Another similar example is the President of an organization getting a weekly email outlining the physicians who were late or had a late first case start time. The President can use this information as proof to the physician of repeated tardiness or continuous late first case starts, which could help change the physician's behavior.

Financial incentives can also entice stakeholders to get on board with process improvement initiatives or make changes. Lee et al. (2019) described the use of financial incentives to increase first case on-time start and saw an increase of 42% in the number of on-time start times. An improvement in first case on-time starts can result in cost savings; however, savings must exceed the financial incentives' costs. Financial penalties may also be applied to surgeons who are regularly late for their first case by reducing their OR block time and the number of procedures they can schedule.

6.3 Lean and Six Sigma

The manufacturing industry has demonstrated significant improvements in process outcomes through the use of Lean and Six Sigma methodologies. The healthcare industry has implemented these strategies for process improvement initiatives as well. The Lean method was first used in the Toyota automotive manufacturing process, developed by Taiichi Ohno. The Lean process looks at eliminating eight types of waste that do not add value including eliminating defects, overproduction, waiting, inventory, transportation, motion, unused talent, and over-processing. The goal of Lean is to continuously reduce waste to improve workflow to maximize time, personnel, and resources (Cima et. al., 2011). Six Sigma is a statistical analysis tool

developed by Motorola to decrease variation. The goal of Six Sigma is to make precise standardized processes by using statistical methods. Six- Sigma methodologies use the Define, Measure, Analyze, Improve, and Control (DMAIC) approach, which outlines the steps needed to decrease variation. The blended approach of Lean and Six Sigma uses the DMAIC structure relying on executive leadership support, process mapping, employee engagement, and sharing performance metrics to improve the OR's financial performance and efficiency (Tagge et al., 2017).

Multiple studies have shown success in implementing Lean Six Sigma into the OR. A study done by the Department of Anesthesiology at the University of Oklahoma College of Medicine demonstrated an improvement in the OR with the use of Lean Six Sigma. The Oklahoma University (OU) Medical center is the only level trauma center in Oklahoma, resulting in constant demand for ORs. With the increase in demand, the medical center implement a process improvement initiative in the OR. OU Medical center saw a 9% increase in the total number of cases performed in their OR, a 14% increase in their number of inpatient cases, and only a 5% increase in the number of OR minutes. The study did not demonstrate a change in turnover time; however, the time the patient entered the OR to procedure start time decreased from 40 to 34 minutes. In addition, the time from the procedure ending to the patient leaving the OR decreased from 10 to 8 minutes. The study also found an increase in block utilization from 68%-74% and room utilization increase from 56%-68%. These improvements increased OR revenues by 14% from 2011 to 2012 and 19% from 2012 to 2013. The Department of Anesthesiology used the Lean Six Sigma tools to identify variation and waste in their process to create an efficiently run OR (Bender et. al., 2015).

Another study conducted by the Departments of Cardiothoracic Surgery, Hospital Operations and Anesthesiology at NYU Langone Health in New York City was designed to

decrease the operating room OR turnover time for two surgeons by applying Lean principles. Stakeholder groups, including EVS, transport, sterile processing, and nurses, mapped their entire surgical procedure process from when the patient is admitted to the transfer to the PACU. A core project team evaluated the processes to identify non-value-added steps. This group decreased the operating room turnover time from 37 minutes to 14 minutes (Cerfolio et. al., 2019). The Division of Pediatric Surgery at Loma Lind University Children's Hospital in California conducted a similar study applying the Lean Six Sigma approach to redesign all surgical services at the Children's Hospital. With the full use of the Lean Six Sigma approach, this study decreased their mean OR turnover time from 45.23 minutes to 35.76 minutes. The Children's Hospital achieved a coordinated multidisciplinary process improvement redesign to improve all surgical services' turnover time (Tagge et al., 2017).

7.0 UPMC Presbyterian Process Improvement Project

UPMC is a large academic medical institution based in Pittsburgh, Pennsylvania. UPMC has 40 hospitals throughout eastern and central Pennsylvania, the largest being UPMC Presbyterian ("Why UPMC", "no date"). UPMC Presbyterian is the 5th largest academic medical center in the country, providing a full range of health care services from inpatient, outpatient, and emergency. UPMC Presbyterian is also a leader in neurosurgery, critical care medicine, trauma services, cardiology, and cardiothoracic surgery, with 1,100 patient beds and 2,080 physicians ("UPMC Presbyterian", 2020). In total, UPMC Presbyterian has 40 ORs, has over 65,000 acute admissions and observation visits, over 42,000 surgeries, and more than 102,000 emergency visits yearly ("UPMC Presbyterian", 2020). With a large number of procedures done daily, it is imperative that ORs run as efficiently as possible.

UPMC Presbyterian has observed some issues with excessive OR turnover time and late first case on-time starts. OR turn over time is classified as "wheels in to wheels out" or the time from when a patient leaves the OR to when a patient arrives in the OR. In July of 2020, a process improvement project was initiated to decrease the UPMC Presbyterian OR turnover time, starting with the trauma service line. This project aimed to investigate the reasons behind the long turnover time at UPMC Presbyterian, looking at one service-line at a time, collecting data to present to physicians to get them on board with a process improvement initiative plan. Over the course of a month, the trauma service line's turnover time was tracked by an OR clinician and administrative representative. The cases were split into three different categories— add on, scheduled, and stand by. Add-ons are classified as cases that were added on the day of due to changes in inpatients' condition, requiring the procedure to be done immediately. An example of an add-on case is a patient that needs a debridement procedure. On day x, they aren't stable enough to have the

procedure but overnight, their condition changes, so they are added today's schedule. Add-on cases are not classified as emergent trauma cases because OR 5 stays free throughout the day for emergent trauma cases. If OR 5 is in use and another trauma case comes to the hospital and needs to use an OR right away, that case would take over an open OR and push back other cases. Scheduled cases are classified as cases scheduled for the day, and stand-by cases are classified as cases in the queue to be performed if there is enough time in the day. An example of a stand-by case is a case that is in the queue if there is enough time in the day to perform that procedure or if a case gets canceled.

FIGURE 1: TRAUMA SERVICE LINE WEEKLY AVERAGE TURNOVER TIME

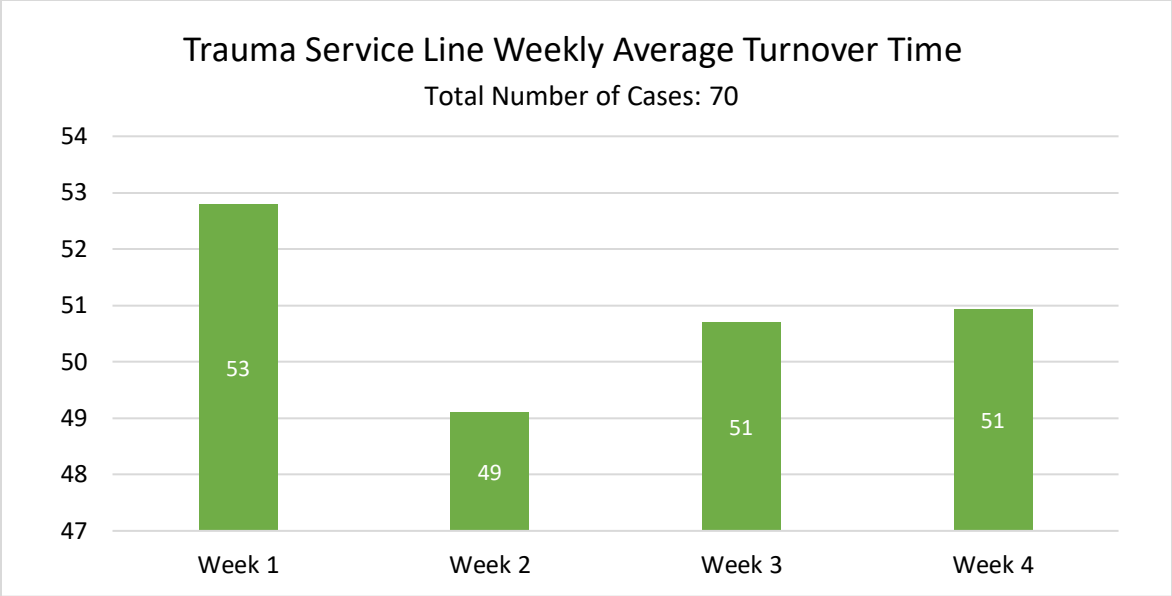
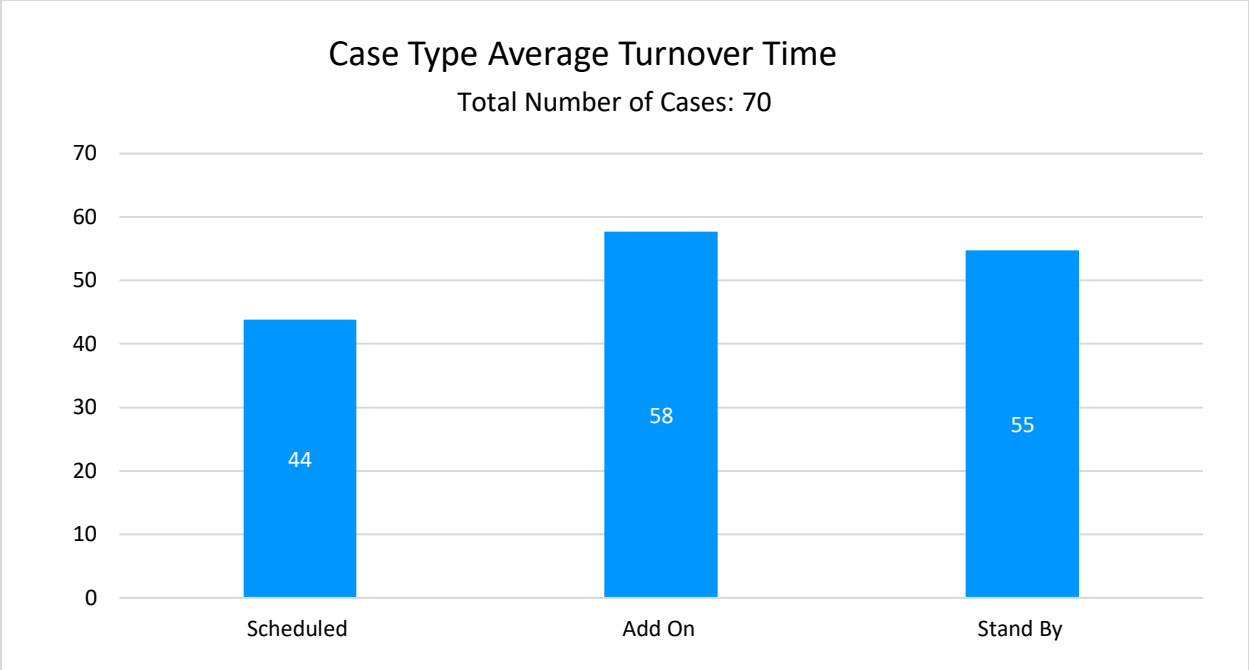


Figure 1 represents the trauma service line's overall weekly average turnover time for all case types add-on, scheduled, and stand by. This graph shows minimal improvement in the general turnover time with the most considerable improvement in week two with an overall 49-minute turnover time, a 4-minute decrease from week one. In weeks three and four, turnover time increased to 51 minutes, making the overall average improvement in turnover time 2.66 minutes.

FIGURE 2: SERVICE CASE TYPE AVERAGE TURNOVER TIME



The four-week average turnover time based on case type add-on, scheduled, and stand by is represented in Figure 2. As seen in the graph, scheduled cases had a shorter turnover time of 44 minutes and add-on and standby cases had significantly longer turnover times of 58 and 55 minutes.

FIGURE 3: WEEKLY AVERAGE TURNOVER TIME BY CASE

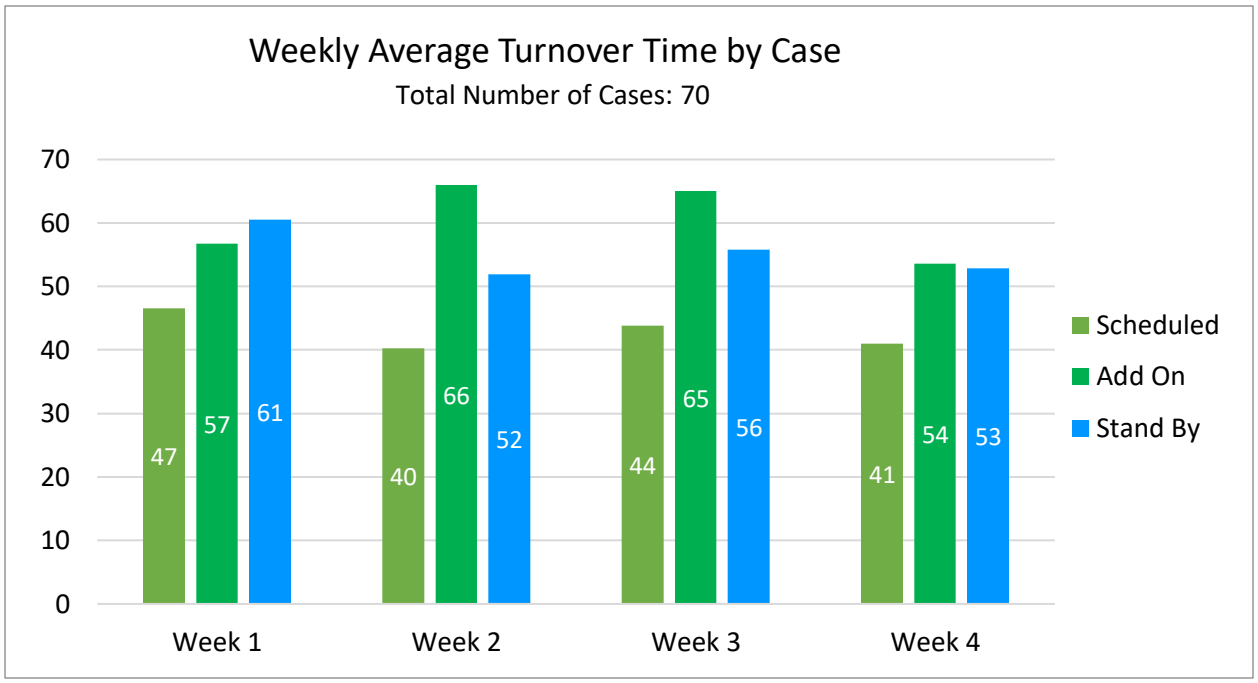
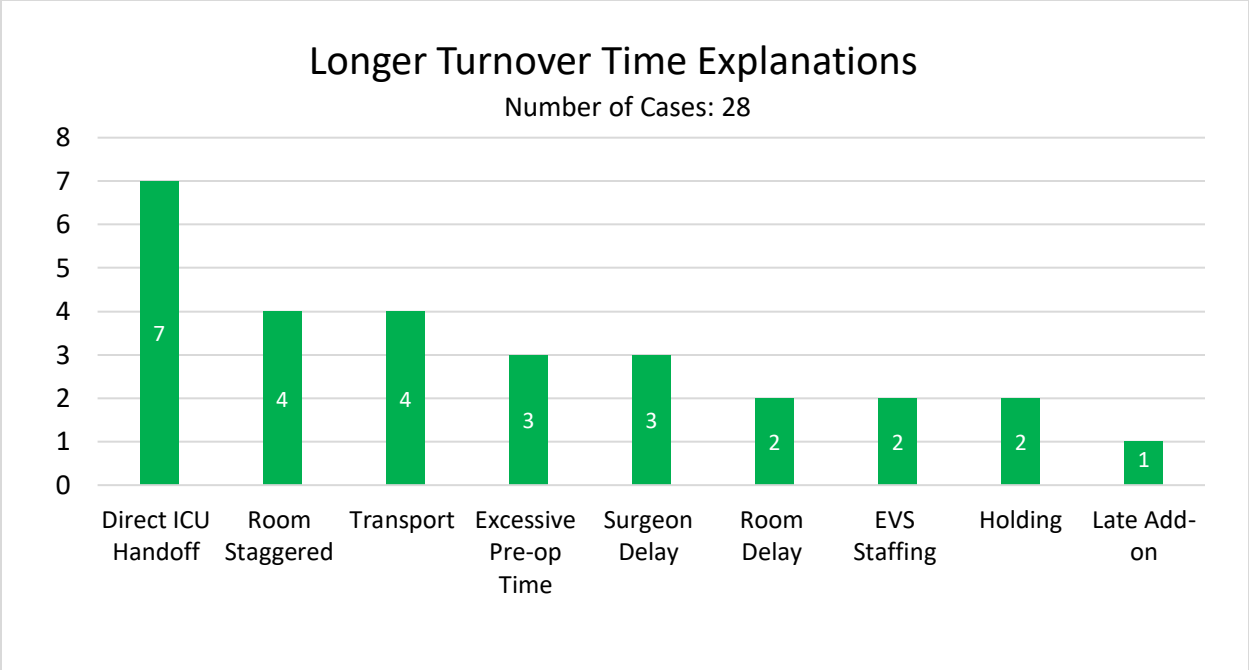


Figure 3 outlines the weekly average turnover time by case type add-on, scheduled, and stand-by. Over four weeks, scheduled cases dropped from an average turnover time of 47 to 41 minutes which is a 6-minute decrease with some fluctuation. In weeks two and three, add-on cases turnover time increased, and week four average turnover time decreased. Stand by cases saw an overall decrease in turnover time that fluctuated over the four weeks. The decreases in turnover time for add-on and stand-by cases were likely due to chance or caseload.

FIGURE 4: LONGER TURNOVER TIME EXPLANATIONS



In addition to tracking the turnover times, the explanations for longer turn overtimes were tracked. There were nine different explanations for longer turnover times: Direct ICU Handoff, Room Staggered, Transport, Surgeon Delay, Excessive Preop Time, Late Add-on, Room Delay, and EVS Staffing. Of those nine explanations, Direct ICU Hand Off (7), Room Staggered (4), and Transport (4) were the top three reasons for excessive OR turnover time.

8.0 Results

During this project, a total of 70 trauma surgery cases were tracked in the UPMC Presbyterian OR. The first week of the project was devoted exclusively to investigating the problems causing prolonged turnover time in the OR, so no interventions were taken to improve OR turnover time. After the first week, one quick fix was identified, and a test was performed to evaluate its effectiveness in decreasing OR turnover time. Specifically, the clinician identified that next-case-patients weren't being called for on-time, so the clinician intervened for the last three weeks to make sure all trauma scheduled cases were called for 45 to 60 minutes before their start time. The scheduled case OR turnover time decreased from 47 to 41 minutes— a 6-minute or 13% difference by implementing this intervention. Stand-by and add-on cases were still tracked, but interventions were not taken to improve their gap time because they are not planned for, so they cause longer gap times.

In the first week of this project, the average overall trauma OR gap started at 53 minutes, and the fourth week's turnover time was at 51 minutes. Looking at just the overall OR turnover time at face value shaving 2 minutes off 53 doesn't seem like such a considerable improvement in turnover time. However, breaking the turnover time up by case type (Add on, scheduled, and stand-by) drilled down where the problems were add-on and stand-by cases have significantly longer gap times compared to scheduled cases. The reason is that stand-by and add-on cases that are not planned for the day these cases are typically inpatients that are unexpectedly in need of surgery that day. So, these cases get called down to the OR later than the scheduled cases. After uncovering this discrepancy in turnover time based on the case type, it changed the project's focus to just scheduled cases. The project found nine metrics affecting OR turnover time.

1. Direct ICU handoff: Patients that come directly from the ICU to the OR create longer turnover times. ICU handoffs take more time because of the high acuity level

of the patients being transferred. ICU patients require multiple health care providers to sign off and facilitate the transfer from the ICU to the OR.

2. EVS Staffing: UPMC Presbyterian has an EVS staffing problem. The hospital is the largest in the organization and has 4 EVS staff members during the first shift (7:00 AM to 3:30 PM), which is less or the same number of EVS staff that smaller hospitals in the system have. On average, during the first shift, each UPMC Presbyterian EVS staff member has 5.6 rooms to clean compared to smaller hospitals whose EVS staff each have an average of 3 rooms to clean.

3. Excessive pre-operative (pre-op) time: Occurs when a patient is in pre-op for longer than 2 hours because they weren't called to come down to OR holding on time or at all.

4. Excessive OR Holding Time: When a patient leaves pre-op, they are taken to holding, located next to the OR. During this stage, the Anesthesiologist and holding nurse prepares them for surgery. Excessive holding time occurs when a patient is in holding before their procedure for longer than 15 minutes.

5. Add-on: A delay relating occurring when a patient is added to the schedule on the day of a procedure.

6. Room Delay: Occurs when staff are not prepared for the cases and don't have the right equipment or supplies needed to perform the case.

7. Room Staggered: Occurs when a physician schedules two or more cases at the same time. The physician has multiple ORs running at once (still meeting compliance

with CMS regulations) and is in the room for the most important or critical parts of the procedure. When rooms are staggered, it causes a longer turnover time because the OR is sitting idle, waiting for the surgeon to finish performing a procedure in a different OR. That time spent waiting for the surgeon prologues the turnover time, which creates the wasted time that could have been used to perform the procedure.

8. Surgeon Delay: A delay caused by a surgeon happens when they are late to their first case or late to the procedure. A Surgeon delay does not relate to a physician having two rooms running at once or rooms staggered.

9. Transport: Delays relating to transport occur when transport takes longer than 30 minutes to get the patient to the OR. Transport time is the time the patient was called for when the patient arrives at holding. Multiple different factors cause a transport delay, like an inpatient unit not getting the patient ready on-time or a patient needing to go to the bathroom prior to leaving.

The top 6 contextual factors causing longer turnover time in the UPMC Presbyterian OR are ICU Hand Off occurring 7 times, room staggered and transport occurring 4 times each, and surgeon delay, late add-on, and excessive preoperative occurring 3 times each. Once more information is gathered on additional service line gap time, the data will be presented to physicians for large-scale process improvement initiatives.

9.0 Discussion and Recommendations

This project was able to decrease scheduled case OR turnover time and identify nine metrics affecting turnover. By identifying a quick fix at the beginning of the project and testing a solution, the trauma service scheduled case OR turnover time decreased by 6 minutes. Every minute the UPMC Presbyterian OR is open, it costs the hospital $10. So, reducing the turnover time by 6 minutes saves $60 per case. If that math is applied to the 70 cases tracked over a month, it would save UPMC Presbyterian $4,200 for a month and $50,400 for a whole year. This project only looked at one service line and one intervention to improve one identified problem causing longer turnover time. If a broad spectrum of interventions were taken across all service lines, then the savings realized by UPMC Presbyterian could be substantial. The quick win recommendation to continue the improvement in turnover time is to encourage physicians to take control of their OR by communicating with staff. When a physician is performing a procedure and knows that they have 45 to 60 minutes left, they need to communicate with the OR nurse to inform the front desk to call for the next patient to get them to the OR on time. Communication is vital in this improvement because when the surgeon was tracking the trauma cases, all cases were promptly called for with enough time to get the patient from preop to holding.

Identifying the nine metrics causing delays and prologued turnover time is a steppingstone to improve OR turnover time. Now that those metrics have been pinpointed, it would be beneficial to investigate to root causes of those problems. The first recommendation to improve UPMC Presbyterian OR turnover time is to apply lean principles to improve processes directly related to the OR. This recommendation is similar to the study done by NYU Langone Health in New York City. The UPMC Presbyterian OR would need to put together a process improvement core project team, including all key OR stakeholders. This team would work with each stakeholder group that

has a hand in the OR process EVS, transport, OR surgeons, OR nurses, OR front desk staff, ICU staff, PACU staff, preop staff, holding staff, and post-op staff to map out all of their processes. After all of the processes are mapped out, the Core Project team will work alongside these stakeholders to find the value and non-value-added steps in their process. With mapping out the process, the Core Project team might find areas where there is a lack of communication or repeated steps can be eliminated. If the process seems to have multiple issues that need a complete overhaul, then UPMC Presbyterian should look into the Lean/Six Sigma approach to use the DMAIC methodology.

Additional recommendations to improve the UPMC Presbyterian OR efficiency are increasing communication by implementing Trauma Service Line morning huddles and case debriefs. Huddles and debriefs will increase the communication with OR staff and create a team environment. The team environment will allow all OR staff to feel like they play a role and have significant ownership in the OR process. It also creates camaraderie between surgical teams, breaking down the hierarchy of OR staff. When staff feels as though they play a role in the process, they have the confidence to speak up when they felt like something wasn't going right or ask questions when necessary. The increase in communication will allow for intraoperative and preoperative efficiency in the OR. Another recommendation is to increase transparency between administration and surgeons. UPMC Presbyterian has a problem with first case on-time starts that appears to be directly related to surgeons coming in late for procedures. On average, in 2019 the average first case started 41 minutes late. It would be beneficial to collect data on the number of times physicians are late to their first case and why. Administrators could use this data to show the physicians how often they are late for cases and the high cascading costs of their tardiness to encourage them to improve their performance. Coupling this with both positive and negative

financial incentives would be beneficial as well. Providing evidence that the physician is a repeat offender coming in late to their first cases and incentivizing them to have a better performance might significantly impact decreasing the number of first cases that start late. The opposite can be done as well. If physicians are repeatedly coming into work late, then penalizing them for pushing back start times by taking away block time might leverage them to come in on time. Taking away block time would be taken in severe situations but might be a way to improve physicians' performance.

Each service line is different and will have individual metrics affecting the OR's turnover time and efficiency. During this project, it would have been beneficial to know the background information of the metrics associated with the OR's inefficiencies and how improvements are made. When tracking different service lines in the future, the information outline will be used to identify metrics associated with the service line's inefficiencies and thoughtfully implement interventions tailored to each service line.

10.0 Conclusion

The OR is one of the most costly areas in the hospital, yet it is also a significant source of hospital revenue. It is critical to find new ways to continually optimize OR efficiency which can only be attained by understanding preoperative and intraoperative metrics that reflect delays in the OR. Improvements can be implemented with the use of short-term interventions like streamlined communication and transparency. Short-term interventions can provide a basis of evidence to support the implementation of long-term interventions like cultural changes and process improvement initiatives like Six Sigma and Lean. Implementing interventions to refine the OR processes have cascading effects that improve employee and patient satisfaction. With all of the improvements in efficiency, job satisfaction, and patient satisfaction comes financial savings that enhance the hospital's bottom line. As seen in the UPMC Presbyterian OR turnover time project, implementing small communication improvements can significantly improve OR turnover time, translating into financial gains. To see larger turnover time changes, UPMC Presbyterian will need to implement additional interventions by further increasing communication and transparency while also implementing Lean process improvement initiatives to streamline inefficient processes.

Bibliography

About UPMC Presbyterian. (n.d.). UPMC Life Changing Medicine. Retrieved January 20th, 2021, from https://www.upmc.com/locations/hospitals/presbyterian/about

Bender, J.S., Nicolescu, T.O., Hollingsworth, S.B., Murer, K., Wallance, K.R., & Ertl, W.J. (2015). Improving operating room efficiency via an interprofessional approach. *American Journal of Surgery.* 209(3), 447-50. DOI: 10.1016/j.amjsurg.2014.12.007

Centers for Medicare and Medicaid Services. (2016, April 18). *Bundled payments for care improvement (BPCI) initiative: general information.* Retrieved January 4th, 2021, from https://innovation.cms.gov/innovation-models/bundled-payments

Centers for Medicare and Medicaid Services. (2020, February 02). *HCAHPS: Patients' perspectives of care survey*. Retrieved January 4th, 2021, from https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HospitalQualityInits/HospitalHCAHPS

Centers for Medicare and Medicaid Services. (2020, December 16). *National health expenditure data- historical.* Retrieved January 4th, 2021, from https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/NationalHealthAccountsHistorical

Centers for Medicare and Medicaid Services. (2020, January 6). *What are the value-based programs?*. Retrieved January 4th, 2021, from https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Value-Based-Programs/Value-Based-Programs

Cerfolio, R.J. Ferrari-Light, D., Ren-Fielding, C., Fielding, G., Perry, N., Rabinovich, A., Saraceni, M., Fitzpatrick, M., Jain, S., & Pachter, L.H. (2019). Improving operating room turnover time in a new york city academic hospital via lean. *The Annals of Thoracic Surgery.* 107(4), 1011-1016. DOI: 10.1016/j.athoracsur.2018.11.071

Cima, R.R., Brown, M.J., Hebl, J.R., Moore, R.,Rogers, J.C., Kollengode, A., Amstutz, G.J., Weisbrid, C.A., Narr, B.J., & Deschamps, C. (2011). Use of lean and six sigma methodology to improve operating room efficiency in a high-volume tertiary-care medical center. *Jornal of the American College of Surgeons.* 213(1), 83-92. DOI: 10.1016/j.jamcollsurg.2011.02.009

Fong, A.J., Smith, M., &Langerman, A. (2016). Efficiency improvement in the operating room. *Journal of Surgical Research.* 204(2), 371-83. DOI: 10.1016/j.jss.2016.04.054

Geppert, P., Daily, D., & Casanova, S. (2018). Achieving surgical supply savings through preference card standardization. *Journal of Medical Systems*, 44(6), 115.DOI: 10.1007/s10916-020-01576-9

Halim, U.A., Khan, M.A., & Ali, A.M. (2018). Strategies to improve start time in the operating theatre: a systematic review. *Journal of Medical Systems.* 42(9), 160. DOI: 10.1007/s10916-018-1015-5

Lee, D.J., Ding, J., & Guzzo, T.J. (2019). Improving operating room efficiency. *Current Urology Reports*. 20(6), 28, https://doi.org/10.1007/s11934-019-0895-3

Rothstein, D.H., & Raval, M.V. (2018). Operating room efficiency. *Seminars in Pediatric Surgery.* 27(2), 79-85. DOI: 10.1053/j.sempedsurg.2018.02.004

Sacks, G.D., Shannon, E.M., Dawes, A.J., Rollo, J.C., Nguyen, D.K., Russell, M.M., Ko, C.Y., & Maggard-Gibbons, M.A. (2015). Teamwork, communication and safety climate: a systematic review of interventions to improve surgical culture. *BMJ Quality & Safety.* 24(7), 458-67. DOI: 10.1136/bmjqs-2014-003764

Tagge, E.P., Thirumoorthi, A.S., Lenart, J., Gaberoglio, C., & Michell, K.W. (2017). Improving operating room efficiency in academic children's hospital using lean six sigma methodology. *Journal of Pediatric Surgery.* 52(6), 1040-44. DOI: 10.1016/j.jpedsurg.2017.03.035

UPMC Presbyterian Shadyside 2019-2020 Administrative Residency [PowerPoint Slides]. (2020). University of Pittsburgh Administrative Residency Presentation, virtual.

Vassell, P. (2016). Improving OR efficiency. *AORN Journal*, 104(2), 121-32. DOI: 10.1016/j.aron.2016.06.006

Why UPMC?. (n.d.). UPMC Life Changing Medicine. Retrieved January 20th, 2021, from https://www.upmc.com/about/why-upmc

Xu, R., Carty, M.J., Orgill, D.P., Lipsitz, S.R., & Duclos, A. (2013). The team curve: a longitudinal study of the influence of surgical team familiarity on operative time. *Annals of Surgery*, 258(6), 953-7. DOI: 10.1097/SLA.0b013e3182864ffe