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Lean approach for streamlining operation theatre changeovers – An Observational study

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Abstract

Background: The operation theatre (OT) is the most productive part in a hospital. Even though changeover duration in an operating room is a non-productive period, it however holds importance. Its effective use requires multidisciplinary teamwork, particularly from supporting services, which are significant in reducing down on operating room turnover time. **Methods:** This observational case study attempts to quantify the changeover time for three operating rooms during the month of January 2024. The lag in changeover time (from wheel out time to incision time), the benchmark time measured was selected as the variable. The information was gathered, organized, examined and recommendations were given to the management team. **Results**: Only 9% of the

changeovers were within the benchmark limit while 91% of the changeovers were delayed due to several reasons. In the first floor OT1 no changeovers were within the benchmark limits and all the changeovers got delayed. In the first floor OT2 8% of changeovers were found within benchmark limits and 92% changeovers were delayed. In the first floor OT3 13% of changeovers were found within benchmark limits while 87% changeovers were delayed. **Conclusion:** The study concluded that multifaceted, unforeseeable, and inevitable causes were the main causes of delays. However, by taking care of the issues that are readily resolved, time can be saved, which in turn will maintain the procedures on schedule and avoid the need to postpone elective cases. Teamwork, multitasking, and simultaneous processing can maximize the use of the OT complex.

Keywords: *Operating Room; teamwork; changeover time; benchmark; Turnover*

INTRODUCTION

The goal and aim of the hospital management team and other stakeholders is to optimize the use of Operating Rooms (OR). Quick turnovers are among the many elements that affect OT utilization rates. Turnover time (TOT) is the time frame that navigates between one patient exiting the OR and the next patient entering it, while Changeover time is the duration between the wheel out time and incision time (Time of surgery). Thus, it also accounts for the time needed for OR setup and clean-up, to lessen contamination, proper cleaning is necessary in between the cases. In most situations, these chores can be finished in 15-20 minutes. More technically challenging instances require more time since additional equipment needs to be upgraded, disinfected, or taken out. In addition to being risky and unpleasant, making rash choices on the day of surgery just to shorten turnaround times could be disastrous since they endanger patient safety. Benchmarking performance provides monetary benefits as well as improving quality and teaching us how to do the right things in the right manner.

Several factors influence changeover time in an OT, including but not limited to, the complexity of surgeries, availability and organization of equipment and supplies, proficiency and coordination of surgical teams, cleanliness and readiness of the operating environment, documentation and administrative procedures, and the utilization of technology and automation. The complexity of surgeries directly impacts changeover time, with more intricate surgeries requiring longer setup and preparation. Availability and organization of equipment and supplies play a crucial role, as delays in locating or replenishing necessary items can prolong changeover time. The proficiency and coordination of surgical teams affect efficiency, with well-trained and synchronized teams able to execute changeovers more swiftly. A clean and organized operating environment facilitates smooth transitions between cases, while efficient documentation and administrative procedures ensure proper scheduling and resource allocation. Integration of technology and automation can help to streamline OT processes and reduce manual tasks, further optimizing changeover time in the OT. Overall, addressing these factors comprehensively is essential for minimizing changeover time and enhancing operational efficiency in the OT.

Healthcare advancements have not eliminated operational issues in hospitals. Hospital operating theatres (OTs) face challenges due to complex surgeries. The duration between surgeries, known as non-operative time, impacts the efficiency of the operating room. Optimizing changeover time improves efficiency and satisfaction. Routine practice minimizes delays and enhances effectiveness while reducing risks [1 - 3]

Surgeons overestimate the duration it takes to switch over an operating room. Only 54% of ORs are used for surgery, with the rest spent on anaesthetic, setup, drapes, and turnover. Hospital officials believe that downtime adds to waste and inefficiencies. It was revealed that the length of OR cleaning is not influenced by the size of the OR, time of day, or length of surgery [4 - 6].

Streamlining Operating Room processes: A Value-Based approach with Lean thinking

"Six Sigma" methods were used to increase productivity, make better use of, and lower changeover time. Surgeon availability in the OR has a favourable impact on turnover time. Using the same OR teams during the day is standard procedure, and skilled orthopaedic circulators and scrub technicians increase the effectiveness of operations. Cleaning after such procedures takes longer, and a separate operating room for emergency surgery is essential. Communication between anaesthesiologist, nursing staff, and technical staff reduces the amount of time spent communicating [7 -9].

Various factors, including patient conditions, surgery timing, and surgeon-employee collaboration, affect OT turnover time. American Society of Anaesthesiologists classes I and II had faster turnover than Class III. Planning for the next case during current surgery, addressing emergencies, and managing complex cases last were beneficial. Efficient teamwork, communication, and preparation were essential for improving turnover times.[10] Optimizing preoperative processes and improving patient transportation can enhance efficiency, alleviate waiting time challenges, and benefit both patients and medical staff [11 – 13]. Previous studies have established benchmarks, while delays negatively impact patient well-being and contribute to staff fatigue [14].

Waste in the materials supply process and patient care procedures can result in higher costs, longer hospital stays, and conflicts between medical professionals and patients. Identifying and addressing these forms of waste is crucial for improving efficiency, reducing costs, and enhancing healthcare quality. Just-in-time delivery requires resource flexibility, good quality, and reliable suppliers [15 – 17].

Visual management is a lean method that streamlines processes and reduces waste. In the context of reducing changeover time in an OT, visual management techniques improve efficiency. One approach involves color-coding equipment systems for quicker identification during changeovers. Visual guides and checklists help maintain consistency and minimize errors. Shadow boards near workstations aid in identifying missing items. Kanban systems with visual cues streamline inventory

management. Workflow diagrams and performance dashboards identify optimization opportunities. Implementing tailored visual management techniques in healthcare facilities can reduce changeover time, improve efficiency, and enhance patient care outcomes [18, 19].

Creating a value stream map is important for problem-solving. Toyota emphasizes understanding issues using facts instead of numerical data, but using workplace data as scientific evidence is crucial. After identifying the root causes, countermeasures should be developed for each cause through brainstorming based on the incident scene's circumstances [20, 21].

This study delves into the operational inefficiencies within the hospital OTs, focusing on changeover times as a critical metric for evaluation. By exploring lean thinking and visual management techniques, this study aims to identify and implement strategies that streamline OR processes, reduce waste, and improve patient care outcomes.

The research question of this study is how do factors such as surgery complexity, team proficiency and equipment availability influence changeover time in OTs and can lean methodologies and visual management techniques effectively reduce changeover times and enhance overall healthcare delivery in hospital OTs? Therefore, the study seeks to address these questions, contributing to the ongoing effort to enhance operational efficiencies in hospital OTs, with the goal of improving patient care quality and safety.

METHODS

This was an observational study conducted for a period of 31 days during the month of January 2024. This study examined the changeover turnover times in scheduled, elective surgeries in operating rooms, calculated from the wheel out time to the incision time. Every procedure that takes place in between surgeries can be recorded, examined, and optimized in a similar manner.

Setting

The project was conducted in the first-floor Operating Theatre (OT) Complex of Max Smart Super Speciality Hospital in Saket, New Delhi. The hospital is a 250-bedded facility with over 50 staff members working in the OT complex. A layout of the OT complex is shown in **figure 1.**

Approximately 400 surgeries are performed monthly in the OT complex first floor. The operational staff includes three housekeeping staff (porters), seven General Duty Assistants (GDAs), and one OT manager responsible for managing all operational factors within the OT complex. Each operating room is staffed with two nurses (one scrub nurse and one circular nurse), one OT technician, and one anaesthetist.

All patients scheduled for surgery on a particular day are required to be admitted the night before and should be taken to the preoperative holding room by 8:00 a.m. on the day of the surgical procedure. For elective procedures, pre-anaesthesia check-ups are typically performed the day before the scheduled procedure. The OT operates from 8 a.m. to 8 p.m., and an average surgical day involves setting up the first case, performing the first operation, completing the changeover process, and repeating the cycle.

Study Sample

A total of 400 surgeries were performed in the operation theatre complex on the first floor, out of which 45, 89 and 95 surgeries were performed in OT1, OT2 and OT3 respectively over 31 days in the month of January 2024.

Inclusion Criteria: All elective cases performed in OT1, OT2 and OT3 within the routine working hours of a given day were included in the study.

Exclusion Criteria: First case of each day, and all emergency cases were excluded from the study.

Primary Data Collection

Data from 15th Jan to 31st Jan 2024 was collected through direct observation, daily rounds, daily OT lists which were tracked and monitored daily.

Data was collected using the following methods -

First was the "Gemba" walk: A workplace walkthrough was carried out to observe the OT employees, tasks, and other related work in the area. Although the primary focus was on changeover processes, the entire patient flow was followed from the inpatient units to the OR to understand the whole process and the perspectives of different HPs. All activities were tracked and observed.

The major steps of the process were mapped, and problems were identified and written on post-it, which were then linked to the process mapped and drawing a Value stream map of the patient flow in the OT and listing out of all the causes in a Fishbone diagram.

With the help of Gemba walk, it was also possible to ask to questions/ interview the healthcare workers involved in the processes to better understand what was happening and why, and the impact on changeover times.

A layout of the OT complex was also drawn using a mobile app and then edited on MS PowerPoint to better understand the patient flow in the OT complex.

Secondary Data Collection

The secondary data was obtained during 1st Jan 2024 to 14th Jan 2024 from the daily OT surgery list from the OT coordinator.

Data Analysis

Each phase of the process was based on Lean thinking such as Gemba walks, Value Process Mapping, Fishbone analysis, Control charts, Scatter diagrams and Bar graphs were used both in the analysis phase and in the evaluating phase to improve the overall processes in the OT Complex.

The interval between the last patient's wheel out and the subsequent patient's incision time, termed as the "Changeover time," was categorized as follows: Over 30 minutes was considered delay in surgery, 30 or less than 30 minutes was considered under benchmark time. Analysis was done using Lean principles, Quality tools, statistical tools and MS Excel.

RESULTS

Value stream mapping

A value stream map illustrating the Changeover process is shown in **figure 2.**

Wheel out to incision time across OT1, OT2, and OT3

The number of surgeries conducted on OT1, OT2, and OT3 were recorded over the period of 1st January 2024 to 31st January 2024. 23 surgeries were included from OT1 during this period, while 58 and 62 surgeries were included from OT2 and OT3 respectively. The summarized data of the Wheel Out to Incision Time based on the recorded data was put together using Scatter diagrams as shown in **figure 3.**

In this study, the benchmark turnover time was considered as 30 minutes. Extension of turnover time beyond 30 minutes was considered a delay in the changeover process. As illustrated, all changeovers were delayed and none of them were found within the benchmark limits (i.e. 30 min) in OT1. In OT2, 92% of changeovers were delayed and while 8% of changeovers were found within benchmark limits. In OT3 87% of changeovers were delayed while only 13% of changeovers were within benchmark limits.

Data Analysis:

Average

The Average Wheel out to Incision Time as analysed for all the OTs were: OT1: 65 mins; OT2: 52 mins and OT3: 53 mins respectively. The overall Average Wheel out to Incision Time for all the three OTs is 56.66 ~ **57 minutes.**

Range

The Range of Wheel out to Incision Time as analysed for all the OTs were: OT1: 35-160 mins; OT2: 20-130 mins and OT3: 20-180 mins. The overall Range of Wheel out to Incision Time for all the three OTs is 20 to 180 minutes.

Median

The Median Wheel out to Incision Time as analysed for all the OTs were: OT1: 60 mins; OT2: 50 mins and OT3: 45 mins. The overall Median Wheel out to Incision Time for all the three OTs is 50 minutes.

Evaluating changeover time in OT1, OT2, and OT3 against benchmark standards

Figure 4 shows the control charts illustrating the changeover time in OT1, OT2, and OT3 against benchmark standards. It can be concluded from the data interpretation that:

Approximately none of the changeovers were found within the benchmark i.e. 30 mins in OT1, all changeovers were delayed. Around 8% of changeovers were found within the benchmark i.e. 30 mins in OT2, while 92% of the changeovers were delayed. Around 13% of changeovers were found within the benchmark i.e. 30 mins in OT3, while 87% of the changeovers were delayed.

Probing bottlenecks for enhanced operational effectiveness using fishbone diagram

The causes for the delays in the surgeries recorded in OT1, OT2, and OT3 were analysed and have been presented in a fishbone diagram in **figure 5.**

Preoperative delays stemmed from incomplete patient preparation, including positioning and documentation issues. Transportation delays from the ward to the operation theatre affected overall time management. Additionally, inadequate setup of the operating room, including equipment availability, contributed to further delays during surgical procedures. Addressing these issues is crucial for optimizing efficiency in the surgical process.

Staffing shortages, including insufficient OT personnel, created heavy workloads and prolonged changeover durations. Inadequate coordination among the surgical team and support staff resulted in confusion and significant delays. Patient-related issues, such as last-minute cancellations or missing documents, hindered timely transfers to the OT. Communication gaps and logistical challenges further contributed to delays in surgical procedures. Improving staff levels, coordination, and communication is essential for addressing these issues.

DISCUSSIONS

Statement of principal findings

According to this observational study, only 9% of the changeovers were within benchmark limit while 91% of the changeovers were delayed due to several reasons. In the first floor OT1 no changeovers were within the benchmark limits. All changeovers got delayed. In the first floor OT2 8% of changeovers were found within benchmark limits. 92% changeovers were delayed. In the first floor OT3 13% of changeovers were found within benchmark limits while 87% changeovers were delayed. Recent observational studies have highlighted the challenges in operating theatre efficiency, with findings indicating that only a small fraction of changeovers meet the established benchmark limits [11,12,13 &14].

Strengths and limitations

The study aimed to track the intervals between Wheel out and incision time; to evaluate the root causes of changeover time delays in ORs; and to give recommendations to the management team that will help the hospital staff efficiently utilize ORs and maximize productivity. One of the primary strengths is to provide real-world insights through observing the hospital's actual changeovers in different OT that allows for a comprehensive understanding of the processes, challenges, and delays that occur in real-time. The study's findings on the percentage of changeovers meeting or failing to meet benchmark limits provide a valuable benchmarking tool for other hospitals. This comparative analysis not only highlights areas of concern but also sets a performance standard for future operational improvements. This study also underscores the importance of efficiency not just for operational metrics but also for patient care quality as well.

This study did not include evaluations of clinical outcome against surgical technique, or the length of time taken during a surgery, nor did it include the amount of time needed for the surgical process. The diversity of procedures can be significantly influenced by each of the variations among surgeons, as the duration of surgery is influenced by their level of expertise and knowledge.

Interpretation within the context of the wider literature

The common causes of start time delays were inadequate planning, poor teamwork and communication, and a shortage of OT staff. Manpower is typically needed for tasks like moving patients both inside and out of the operating room, placing patients, cleaning, disinfecting, and other tasks that must be completed before the operation can begin. Start time operative delays are a result of lack of accountability and general lack of training.

It is necessary to prepare the necessary materials and equipment for the OT cases in advance. The use of more modern technology (computerization, ultrasound, fibre optic, and sterilization systems) makes it possible to schedule cases in a timely manner and to prepare them in an appropriate order. It is necessary to guarantee better interdepartmental cooperation and adherence to preanesthetic

guidelines. Anaesthesiologists must oversee the process as the OT Manager and do their duties on schedule and with promptitude. The requirement for efficient and well-organized OT planning for ongoing quality improvement is being defined by this observational study, which is a positive step forward.

Implications for policy, practice, and research

In addition, further research could include first cases, patient feedback, problems faced by attendants and management's perspective. Highlighting the variance in efficiency between different OTs encourages a culture of learning and collaboration. Sharing best practices among teams can lead to improved outcomes across the board, leveraging the strengths of one area to support the performance of another. By providing a detailed examination of changeover time and identifying specific areas for improvement, the study lays the groundwork for enhancing the efficiency and effectiveness of hospital operating theatres.

Conclusions

Optimizing Operation Theatre (OT) changeover times in healthcare involves considering factors like procedure complexity and team size. Lean management principles aim to minimize downtime, with targets ranging from 10 to 30 minutes. Standardized procedures, workflow optimization, and visual management techniques help achieve efficiency while ensuring patient care and safety standards are maintained through continuous evaluation and improvement.

Utilizing innovative data collection methods, the study aimed to identify opportunities for improvement in operating theatre, particularly focusing on changeovers as they constitute a significant portion of the surgical day. Implementing lean methodologies to streamline changeovers can lead to various benefits such as reducing patient waiting times, improving scheduling accuracy,

enhancing productivity, and decreasing costs by utilizing operating theatres more effectively. However, the study found that there was a lack of standardization and variations in practices.

To enhance OT efficiency and minimize changeover time, effective communication among OT staff, surgeons, and anaesthetists is crucial for patient safety. Dashboards displaying room turnover status facilitate early communication, ensuring preparedness. Advance preparation of supplies and equipment is essential, achieved through efficient storage and inventory management. Implementing time tracking tools allows analysis of each step in the changeover process, identifying bottlenecks. Utilizing checklists ensures systematic completion of tasks, preventing omissions and promoting consistency. Overall, these measures optimize OT processes, reduce changeover time, and enhance hospital operational efficiency.

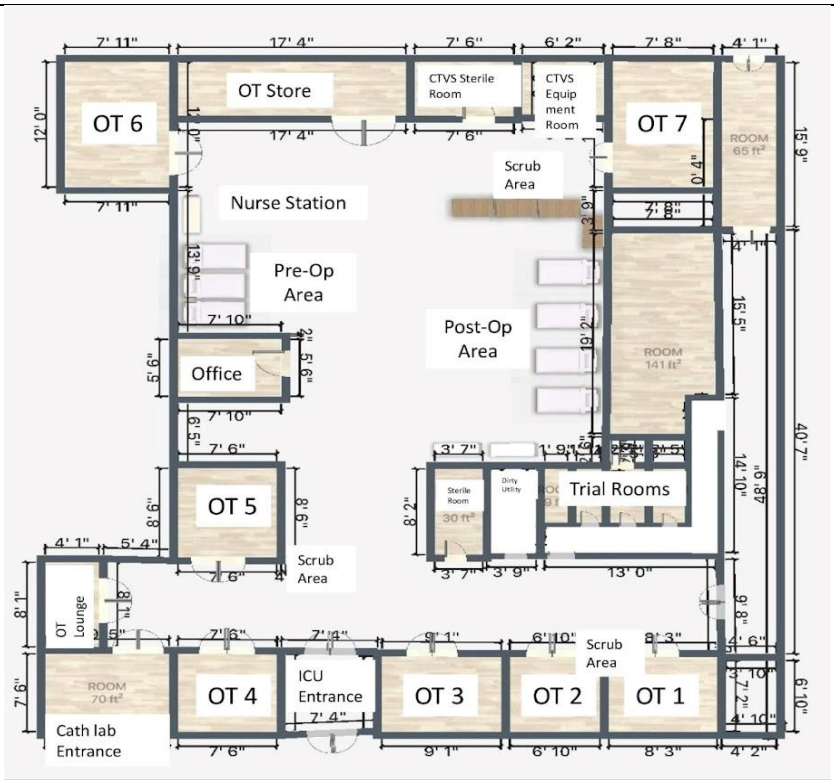

Figure 1: Layout of OT complex (1st floor) - The OT Complex comprises 7 operating rooms, a pre-operative area, post-operative area, OT Lounge, office, OT store, CTVS Sterile

room, CTVS Equipment Room, changing rooms for men and women, and washrooms as shown above.

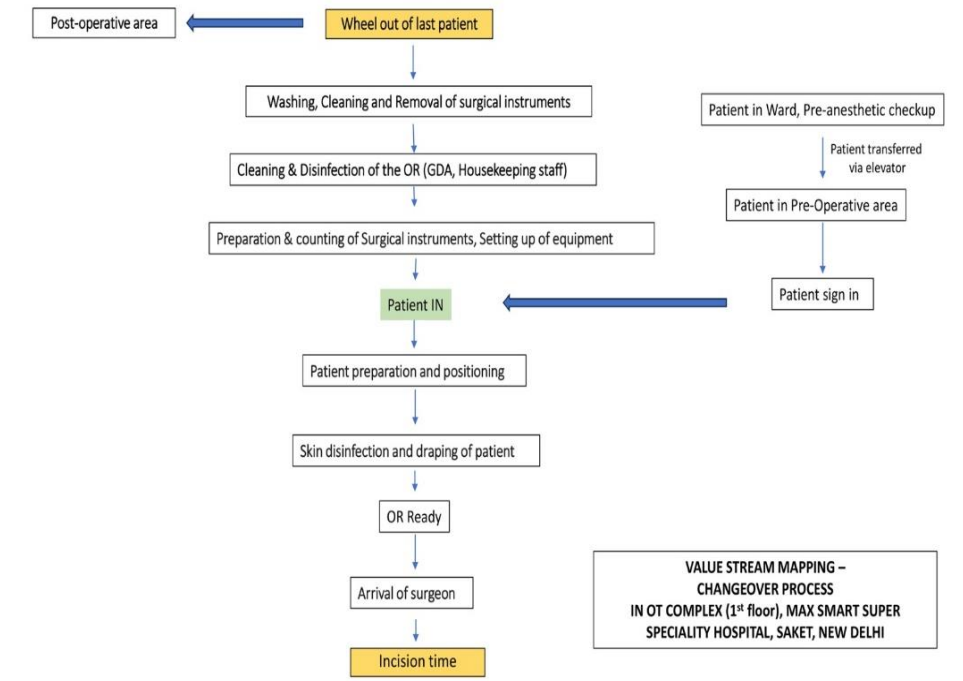

Figure 2: Value Stream Map of the Changeover processes in OT complex (1st floor)

The OT workflow as shown above is a series of well-coordinated activities which are performed to ensure the smooth progression of each procedure.

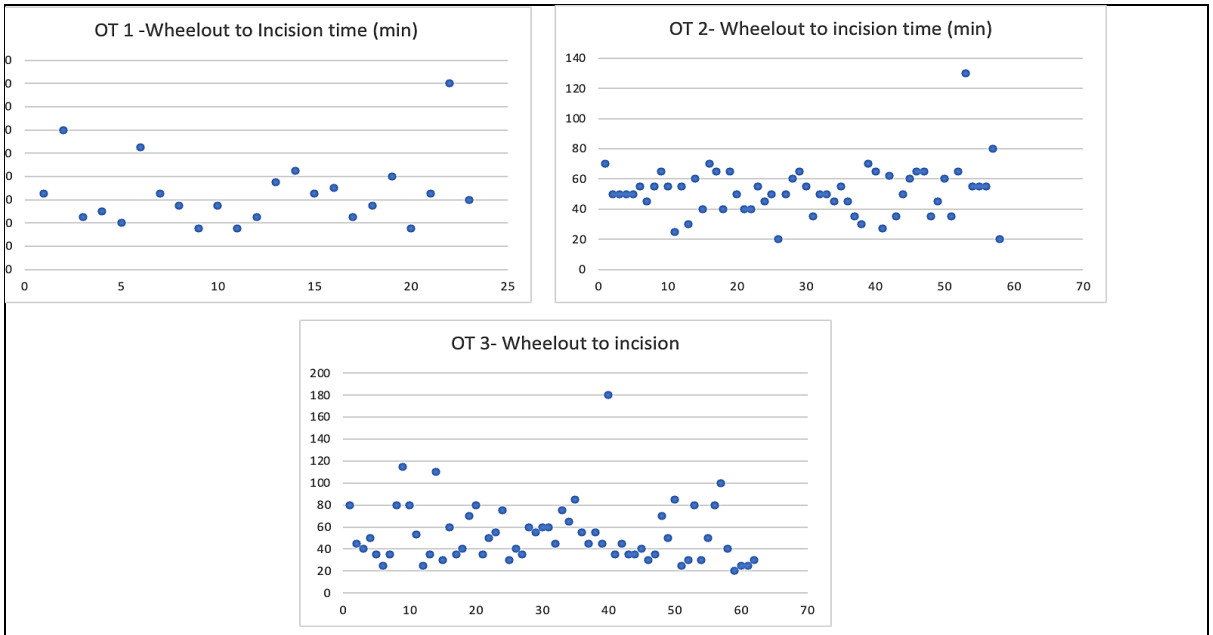

Figure 3: Scatter diagrams illustrating the Wheel out to incision time in minutes for OT1, OT2 and OT3 - Time recorded was between Wheel out and Incision denoting Changeover time in surgery. A total of 200 surgeries were monitored in this study, 41 from OT1, 89 from OT2 and 70 from OT3, performed during January 2024. As mentioned in the exclusion criteria, the first case of each day and all emergency cases were excluded from the study. Thus, based on the exclusions, the number of surgeries considered for the study are 143 (OT1: 23; OT2: 58; OT3: 62)

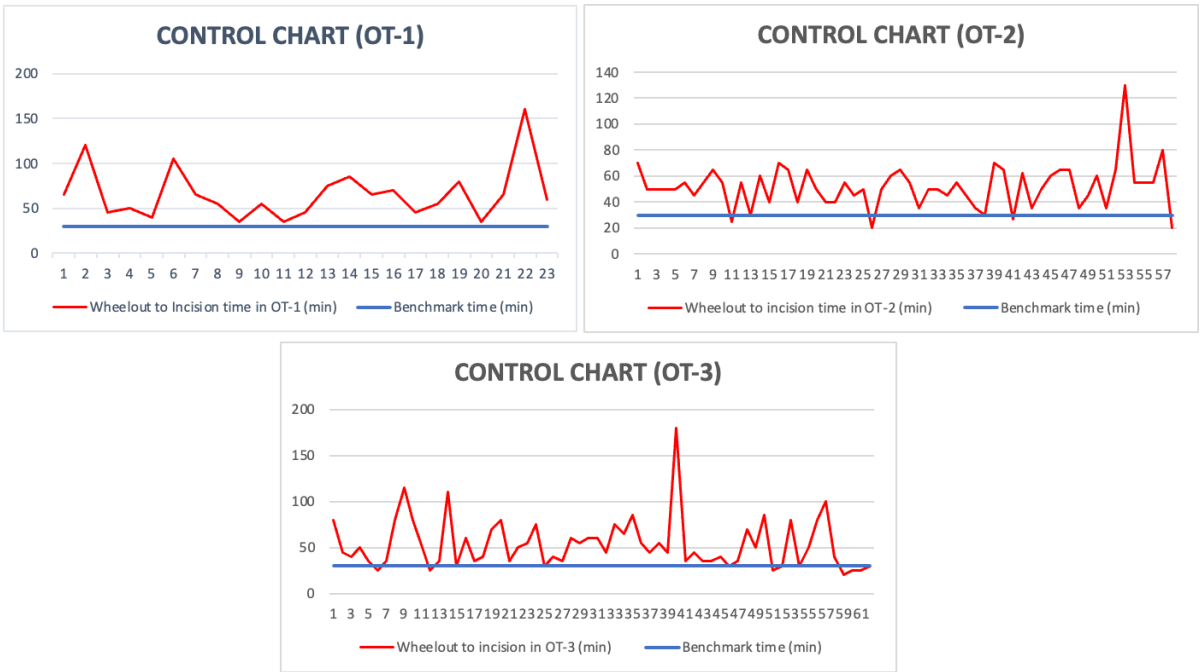

Figure 4: Control Charts Illustrating the Wheel out to Incision duration in OT1, OT2, and OT3 Against Benchmark Standards i.e. 30 minutes.

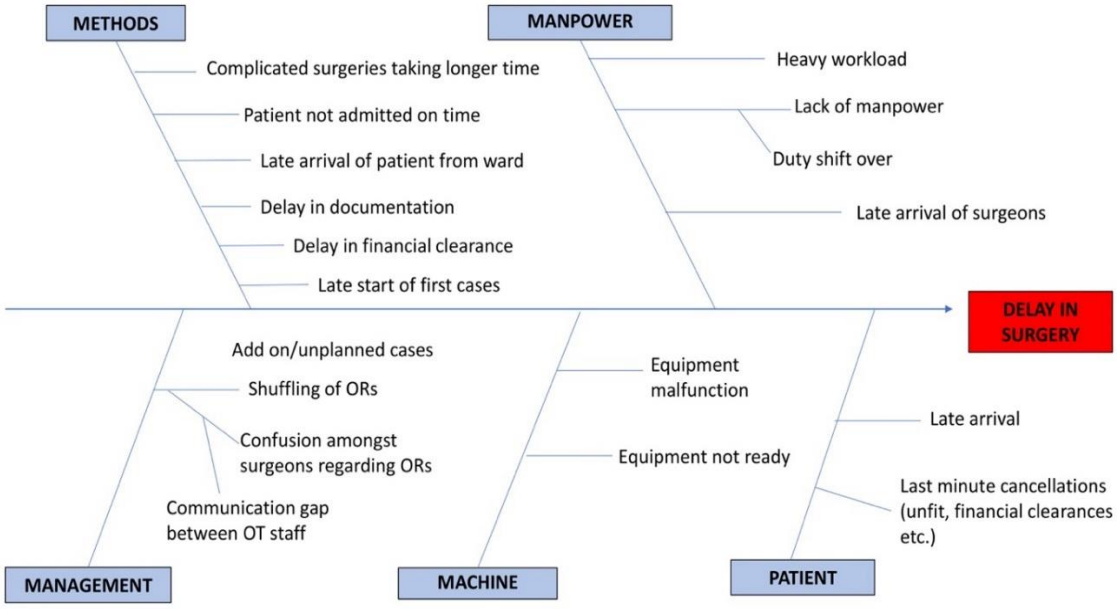

Figure 5 : The delays in changeover time (Wheel out to Incision Time) can be attributed to several key factors that occur at various stages of the surgical process as illustrated in the Fishbone diagram above.

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