Improving Efficiency and Reducing Costs in Robotic Surgery: A Lean Six Sigma Approach to Optimize Turnover Time

Alexis Sanchez  
Orlando Regional Medical Center

Luis Herrera  
Orlando Regional Medical Center

Andre Teixeira  
Orlando Regional Medical Center

Michael Cheatham  
Orlando Regional Medical Center

Desren Gibson  
Orlando Regional Medical Center

Victoria Lam (victoria.lam21@gmail.com)  
Orlando Regional Medical Center

Oriana Guevara  
Orlando Regional Medical Center

Research Article

Keywords: Operating Room (OR) Turnover Time (TOT), Lean Six Sigma, Efficiency, Cost Reduction.

Posted Date: March 1st, 2023

DOI: https://doi.org/10.21203/rs.3.rs-2626429/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License
Abstract

Operating room (OR) turnover time (TOT) is the time it takes to prepare an OR for the next surgery after the previous one has been completed. Reducing OR TOT can improve the efficiency of the OR, reduce costs, and improve surgeons’ and patients’ satisfaction. To evaluate the effectiveness of an Operating Room (OR) Turnover Time (TOT) reduction initiative using the Lean Six Sigma methodology (DMAIC) in the bariatric and thoracic service lines. Performance improvement strategies consisted on simplifying steps (surgical tray optimization) and concurrent steps (parallel task execution). We compared two non-consecutive months (pre-implementation and post-implementation). A paired t-test was used to assess whether the difference in the measurements was statistically significant. The study found that TOT was reduced by 15.6% from an average of 35.6 minutes with a standard deviation of 8.1 to an average of 30.09 minutes with a standard deviation of 9.7 (p < 0.05). Specifically, in the bariatric service line, TOT was reduced by 17.15% and in the thoracic service line, TOT was reduced by 9.6%. No adverse events related to the initiative were reported. The results of this study indicate that the TOT reduction initiative was effective in reducing TOT. The efficient use of operating rooms is crucial in hospital management, as it not only impacts finances but also affects the satisfaction of surgical teams and patients. This study shows the effectiveness of Lean Six Sigma methodology in reducing TOT and improving the efficiency in the OR.

Introduction

Surgical care is a significant component of hospital expenses, with time being one of the most important factors impacting costs (1,2). The cost of operating rooms per minute can range from $30 to $100 (3,4), with recent studies reporting an average of $36 to $37 per minute (5).

Despite the undeniable advantages that robotic surgery offers in minimally invasive procedures (6–8), its incorporation also significantly increases the complexity of the operating room configuration (9,10). This complexity can affect the efficiency of the operating room, which is why it is important to continuously monitor and identify opportunities for increasing the efficient use of the operating room.

Operating room (OR) turnover time (TOT) is the time it takes to prepare an OR for the next surgery after the previous one has been completed. Reducing OR TOT can improve the efficiency of the OR, reduce costs, and increase the number of surgeries that can be performed (11,12). TOT is a critical indicator of efficiency as prolonged turn-over times not only decrease efficiency and increase costs, but they are also associated with decreased staff motivation and patient satisfaction (13). Poor efficiency in this sense can lead to situations in which during a surgical day, the surgeon spends less than 50% of the day actually operating (14,15).

To address this issue, our center has decided to apply the Lean Six Sigma methodology, which is a consolidated methodology used in the manufacturing sector (16,17), to identify and implement strategies to improve TOT in the bariatric and thoracic service lines. The Lean methodology is used to eliminate
waste and the Six Sigma approach aims at decreasing variability, thereby increasing consistency and quality of the process. In recent years, this methodology has been applied in multiple non-manufacturing industries including healthcare and specifically in the surgical area (18,19).

The purpose of this study is to evaluate the effectiveness of the TOT reduction initiative using this methodology in the bariatric and thoracic service lines. By using this approach, we hope to achieve a significant reduction in TOT, which will improve OR efficiency, reduce costs, and increase the number of surgeries that can be performed.

**Methods**

This initiative aimed to improve the efficiency of the operating room using the Lean Six Sigma approach (DMAIC) (Fig. 1). The problem of prolonged Turnover Time (TOT) in multiple service lines performing robotic surgery procedures was identified (Define phase). An EMR interactive dashboard was used to objectively measure TOT (Measure phase) and process analysis (Analyze phase) revealed that strategies such as eliminating unnecessary steps, rearranging steps, simplifying steps, and performing steps in parallel could be implemented to increase efficiency and consistency in the process (Fig. 2).

The initiative (Improvement phase) focused on two main strategies: surgical tray optimization and parallel task execution. Parallel task execution involves having the scrub technician set up the DaVinci Robotic System while the patient is being prepped for the procedure, which can save time by eliminating the need to wait for the robotic system to be set up and reducing the time the surgical team must wait before starting the procedure. Surgical tray optimization, on the other hand, involves ensuring that the surgical tray contains only the necessary instruments, which can reduce the time needed to prepare the operating room for the next surgery.

The study evaluated the Operating Room (OR) Turnover Time (TOT) for two service lines: Bariatric and Thoracic Surgery. TOT was defined as the time interval between "wheels out" to the next patient "wheels in". Only measurements related to the same specialty were considered for the case preceding the turnover period and the case following the TOT period. To determine the impact of the initiative, the average OR TOT of two non-consecutive months was compared (Pre-implementation and Post-implementation). Continuous monitoring of OR TOT (Control phase) will ensure that objectives have been met or necessary corrective actions can be taken.

A statistical analysis (paired t-test) was used to determine if the difference in the measurements was statistically significant. As this study did not involve human subjects, approval from the Institutional Review Board (IRB) or informed consent was not required.

**Results**

The optimization of the surgical tray was conducted in four stages: observation of procedures, modifications, trial implementation, and cost analysis. The initiative was completed in a total of two
months. In contrast, the concurrent task of parallel execution was relatively simple to implement and only required a few meetings with the operating room staff.

The study conducted an analysis of 53 measurements prior to the implementation of strategies and 93 measurements post-implementation. The results revealed that overall, the TOT (turnover time) decreased by 15.6% from an average of 35.6 minutes with a standard deviation of 8.1 to an average of 30.09 minutes with a standard deviation of 9.7 ($p < 0.05$) (Fig. 4).

Specifically, in the bariatric service line, the TOT was reduced from an average of 32.3 minutes with a standard deviation of 5.6 to an average of 26.7 minutes with a standard deviation of 8.9, representing a 17.15% reduction ($p < 0.05$). In the thoracic service line, the TOT was reduced from an average of 38.8 minutes with a standard deviation of 9.0 to an average of 35.1 minutes with a standard deviation of 8.7, representing a 9.6% reduction ($p = 0.09$) (Fig. 5). Importantly, no adverse events related to the initiative were reported.

**Discussion**

The efficient use of operating rooms is crucial in hospital management, as it not only impacts finances but also affects the satisfaction of surgical teams and patients. Optimizing TOT is especially important when the same surgeon and/or surgical team performs successive cases. The results of this study show that the TOT reduction initiative was effective in reducing TOT for the bariatric and thoracic service lines at our center. It is important to note that this plan is part of a larger Lean Six Sigma initiative to improve processes and increase efficiency in the OR.

Lean six sigma has been used to investigate and improve several aspects of the healthcare industry, including information processing, outpatient clinics, and inpatient settings (20,21). Experiences of its use in process optimization in the surgical area have been described by some authors (18,19). This approach is based on the use of objective data that focuses on the efficiency and effectiveness of processes.

Performing activities in parallel is not a specific technique within the Lean Six Sigma methodology, but it is a strategy that improves process efficiency and reduces waste. The Lean methodology focuses on eliminating waste and maximizing efficiency in processes. Additionally, Six Sigma, the other half of the Lean Six Sigma methodology, aims to reduce variability in a process (13,14). Surgical tray optimization helps to achieve this goal by standardizing the process and reducing the potential for errors.

The optimization and standardization of surgical trays simplifies table set-up and counting time, and reduces the workload in the Sterilization Process Department (SPD), the financial impact of this strategy has been previously reported by the authors (22).

The strategies implemented resulted in substantial improvements and a significant reduction in non-operative OR time. It is essential to emphasize the critical role of aspects such as role definition, communication, commitment, engagement, and active participation. Involving the surgical team, nursing
staff, and OR support staff in the process of optimizing surgical trays and developing protocols for parallel tasks is crucial to ensure that their needs and perspectives are taken into account.

When implementing the initiative, it is important to ensure that the surgical teams for these service lines are properly trained and educated on the new protocols and procedures being implemented. In this study, the variation in OR TOT increased (SD 8.1 min vs SD 9.7 min), this could be due to the fact that the new procedures implemented have not yet been fully adopted and are still being fine-tuned.

The impact on thoracic surgery measurements was lower, with a 9.6% reduction that is not statistically significant. This may be due to the complexity of the operating room and procedures. It is crucial to continuously monitor the process and consistently implement strategies for improvement, including shifting from an inefficient culture to one of continuous improvement.

It is important to acknowledge the limitations of this study, including that it was conducted at a single center, and the results may not be generalizable to other surgical centers. Additionally, this study focused on two surgical specialties, bariatric and thoracic surgery, and the results may not be applicable to every surgical specialty. Furthermore, the study did not consider the number and experience of staff present during TOT.

Other initiatives that could be implemented to reduce TOT in robotic surgery include improving communication and coordination among the surgical team, using data visualization and analytics tools to monitor and optimize the surgical process, offering training and education programs to help surgeons and surgical staff develop the necessary skills and knowledge to perform robotic surgery efficiently, and using virtual reality simulation to familiarize the surgical team with the surgical procedure and reduce the time needed for set-up (2,9,23). Our team is currently working on some of these initiatives

**Conclusion**

In summary, the implementation of Lean Six Sigma methodology in the TOT improvement project for Bariatric and Thoracic Surgery services at our center has been successful in reducing non-operative OR time and increasing efficiency in the surgical area. However, the results in the thoracic service line were not statistically significant.

The implementation of strategies such as simplifying steps and performing steps in parallel has led to an improvement in TOT. Additionally, the use of an EMR interactive dashboard to objectively measure TOT has been crucial in identifying problem areas and implementing effective solutions. It is important to note that the success of this project is due in large part to the high level of commitment, coordination, and active participation of all members of the surgical team. Continuous monitoring and reinforcement of the strategies implemented are key to maintaining and further improving the efficiency of the surgical area. Overall, the results of this project demonstrate the potential of the Lean Six Sigma methodology as a powerful tool for improving efficiency and reducing costs in the surgical setting.
Declarations

The authors declare that no funds, grants or other support were received during the preparation of this manuscript. The authors have no relevant financial or non-financial interest to disclose.

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Alexis Sanchez, Victoria Lam and Oriana Guevara. The first draft of the manuscript was written by Alexis Sanchez and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

This study did not involved human participants.

References

https://doi.org/10.1007/s11701-020-01121-3


https://doi.org/10.1002/hpm.966


https://doi.org/10.1097/qmh.0b013e3181eb140e


https://doi.org/10.1097/ta.0b013e3181e70f90


Figures
Figure 1

Lean Six Sigma approach (DMAIC)

Figure 2

Improving a Multiple Steps Process
Figure 3

See image above for figure legend
Figure 4

See image above for figure legend