RESEARCH ARTICLE

An Efficiency Model for Decreasing Operative Room Turnover Time for Total Joint Arthroplasties

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Received: 10 January 2024 *Accepted: 12 June 2024*

Abstract

Objectives: Despite an increased demand for total joint arthroplasty (TJA), rising health-care costs and bundling of payments by payers have shifted the focus to improving operating room (OR) efficiency. This study aimed to assess the efficacy of an efficiency model that optimized instrument trays on decreasing OR turnover time (TOT) and the benefits made possible by this improved efficiency.

Methods: All primary TJA procedures performed by a single fellowship-trained surgeon from January 2022 to August 2023 were reviewed. The surgeon partnered with Zimmer Biomet to condense the total knee and total hip arthroplasty instrument trays from seven to three trays each. Patient in OR time and patient out of OR times were collected and used to calculate TOT. Mean TOTs pre-efficiency model implementation (January – October 2022) and post-efficiency model implementation (March – August 2023) were compared. Annual cost savings were calculated based on an average cost per one minute of OR time of $47.99 and an average cost for the Sterile Processing Department (SPD) to process a single TJA tray of $79.41.

Results: Following implementation of the efficiency model, the average OR TOT significantly decreased by 19 minutes ($P < 0.0001$), a greater than 44% reduction in TOT. At this surgeon's current case volume, conservatively estimated at 280 primary TJA cases per year, annual savings in OR and SPD processing costs were $169,597 and $88,939, respectively. Moreover, this led to increased case volume per operative day.

Conclusion: A small-scale intervention such as optimizing instrument trays for TJA is a valuable and sustainable solution to improve efficiency in the OR by decreasing OR TOT, thereby generating considerable cost-savings and opportunity to increase surgical volume.

Level of evidence: III

Keywords: Efficiency, Instrument tray, Total hip arthroplasty, Total knee arthroplasty, Turnover time

Introduction

Total joint arthroplasty (TJA) is one of the most common procedures performed in the United States, with the volume of both primary and revision cases dramatically increasing over the past couple of decades due to the aging "baby boomer" population.[1] Despite this increased demand, rising health-care costs, and bundling of payments for TJA, hospitals have had to focus on improving operating room (OR) efficiency to maximize OR utilization.[2-5] Inefficiencies in the OR also result in delayed cases, which places increased stress on patients, the surgeon, and hospital staff, highlighting an overall need for improving OR efficiency without compromising high-quality patient care.

Numerous reasons have been identified that can interfere with efficiency in the operating room. These include improper patient or equipment preparation, insufficient staff availability, and delays in patient transportation.[6-8] Prior studies have identified decreasing OR turnover time, defined as the time elapsed from when one patient leaves the OR to the next patient entering the OR, as a valuable target for improving OR efficiency by using large-scale interventions and multidisciplinary approaches involving

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nursing, anesthesia, and surgical staff.[6,8-12] However, these models depend mainly on human productivity and shared responsibility, making it difficult to consistently reproduce the same outcomes in the long term. In addition, only a few studies have evaluated the direct impact of small-scale interventions, such as standardization of instruments, on decreasing OR turnover time, especially for orthopaedic surgeries.[5,13]

In 2020, Zimmer Biomet launched their Efficient Care Program, which partners with orthopaedic surgeons to condense their instrument trays for total knee arthroplasty (TKA) and total hip arthroplasty (THA) with the idea that only the trays going into the OR are the ones to be used in the surgery. The primary goal of this study was to determine the efficacy of this efficiency model in decreasing OR turnover time at a high-volume tertiary care arthroplasty center. A secondary goal was to evaluate the benefits made possible by improved efficiency, including cost-savings to the hospital and the opportunity to increase surgical volume. In this study, we aimed to assess the OR turnover time after implementing the efficiency model by comparing it with the TOT prior to the change. Moreover, we investigated the financial impact of this change on the practice.

Materials and Methods

Study Design and Data Collection

With approval from our Institutional Review Board, we conducted a retrospective review of patient data from January 2022 to August 2023. Patients were initially identified by medical informatics using Current Procedural Terminology (CPT) codes for primary TKA (27447) and primary THA (27130) completed by a single fellowship-trained arthroplasty surgeon. Patients were excluded if they were under 18 years of age or underwent any procedure other than primary TJA including revision TKA, revision THA, open reduction with internal fixation of periprosthetic fracture or arthroplasty for fracture. The surgeon's case schedule was tracked retrospectively within the institution's electronic medical record (EMR) system and used to confirm the order in which the cases were completed each day. Cases completed between November 2022 and February 2023 were excluded to account for the efficiency model to take effect, which is when Zimmer Biomet and the surgeon condensed the TKA and THA trays from 7 trays each to 3 trays.

Case characteristics collected included date of surgery, type of surgery (billing procedure CPT code), and laterality of procedure. Surgical characteristics collected included patient in OR time (PIR) and patient out of OR time (POR). Turnover time (TOT), defined by the Association of Anesthesia Clinical Directors (AACD) as the time between the patient leaving the OR and the succeeding patient entering the OR for sequentially scheduled cases (PIR of patient two – POR patient one), was calculated.[14]

Data Analysis

Turnover times were stratified into two groups based on date of surgery: pre-efficiency model implementation (January 2022 – October 2022) and post-efficiency model implementation (March 2023 – August 2023). Descriptive statistics including mean, standard deviation, minimum, and maximum were used to compare TOTs between the two groups. Statistical analysis using a Student's *t*-test was used to determine statistical significance between TOT of the two groups, with a *P-value* of less than 0.05 considered to be significant.

Cost-Savings Analysis

Cost-savings were calculated based on the decrease in TOT obtained following the implementation of the efficiency model, the average cost per one minute of OR time, and the average cost to process a single TJA tray by the Sterile Processing Department (SPD). Cumulative OR savings were calculated by multiplying the decrease in TOT by the average number of turnovers per OR each day, multiplied by the number of days in the OR for a single surgeon per year, multiplied by the average cost per one minute of OR time (quantified as $37 per minute).[15] Total savings in SPD processing were calculated by multiplying the number of trays eliminated following Efficient Care implementation, which was four trays in this study, by the average cost to prepare and sterilize a single TJA tray (quantified as $58.18 per primary TKA tray),[16] multiplied by the number of cases done by the surgeon annually. Using the U.S. Official Inflation Data's Inflation Calculator, costs were adjusted for inflation.[17] for the average cost per one minute of OR time, $37 in 2014 is $47.99 in 2023. For the average cost to process a single tray, $58.18 in 2011 is $79.41 in 2023.

Results

There were 158 primary TJA cases in the pre-efficiency model cohort spanning 74 OR days over the ten-month period. 20 cases were excluded because they were preceded or succeeded by a procedure other than primary TJA. In the post-efficiency model cohort, the surgeon performed 133 primary TJA spanning 42 OR days over the five-month period and three cases were excluded for the same reason above. There were 80 TOTs calculated for the pre-efficiency cohort and 89 TOTs for the post-efficiency cohort based on the total cases described above. The mean TOT was 42.7 ± 12.2 minutes (range, 20 to 91) for the pre-efficiency cohort and 23.8 ± 8.4 minutes (range, 12 to 75) for the post-efficiency cohort. The surgeon's caseload was also noted to increase following implementation of the efficiency model from an average of two primary TJA cases per OR day to three primary TJA cases.

Overall, the efficiency model, which consolidated the standard seven TKA and THA instrument trays to three trays each, significantly decreased OR TOT by 19 minutes ($P < 0.0001$). At this surgeon's current case volume, conservatively estimated at 280 primary TJA cases spanning 93 OR days per year (averaging three primary TJA cases per OR day), yearly savings in OR and SPD processing costs were estimated to be $169,596.66 and $88,939.20, respectively.

Discussion

Operating rooms (OR) have historically accounted for up to 60-70% of a hospital's revenue.[7] However, rising health-care costs, limited reimbursements, and a nationwide shift to value-based care have caused hospitals to develop strategies to maximize OR utilization and control costs without compromising high-quality patient care.[4,18] Primary TKA and THA procedures have been a favorable target for optimization over the past decade because of their high demand and large profit margin, which is the total reimbursement available after direct costs.[2] Many institutions also use block booking where an orthopaedic surgeon is scheduled in the same OR for the day, further simplifying the identification of OR inefficiencies. While the current literature supports an array of strategies to improve OR efficiency, few studies provide a sustainable solution without adding human or capital resources.[19] The results of this study demonstrate how a simple, small-scale intervention can produce a greater than 44% reduction in OR turnover time (TOT) for primary TJA, thereby generating over $250,000 in annual cost-savings and a potential to increase a surgeon's case volume.

Operating room turnover time, the non-operative time between surgical cases, is a component that can be used both as a metric and target for improving perioperative efficiency. Delays in patient preparation/transport, anesthesia preparation, and room/equipment preparation have all been identified as reasons for longer turnovers that result in OR inefficiencies.[6-8] In addition, there is a lack of alignment between OR staff where surgeons are incentivized by volume and quality versus nurses and anesthesiologists are commonly paid hourly, which only amplifies this issue.[10] Prior studies have proposed various strategies to decrease OR TOT and enhance OR throughput for orthopaedic surgeries. Small et al.[20] found that dedicating specific ORs made up of staff only assigned to that unit to perform primary TJA procedures decreased TOT by 8 minutes. Smith et al.[12] decreased TOT by 16.2 minutes through modifying OR workflow with parallel processing that included using a procedural block 'induction' room next to the TJA ORs. Attarian et al.[8] also decreased OR TOT by 25 minutes using a multidisciplinary committee of stakeholders who assessed typical OR delays and subsequently implemented various changes like new protocols every quarter. While all three studies were able to significantly decrease TOT, these system-based approaches depend highly on human factors and iteration. They also require additional time and resources to implement. Unless staff are consistently held accountable or incentivized, they can revert to old habits and negate any improvements in efficiency.

This study aimed to provide a new approach to enhance OR efficiency by focusing on the effective utilization of hospital resources. In 2020, Zimmer Biomet launched their Efficient Care Program, which partners with orthopaedic surgeons to condense their instrument trays for total knee arthroplasty (TKA) and total hip arthroplasty (THA). Like Cichos et al.[13] who found that removing redundant, unused instruments from orthopaedic trays decreased cleaning times and reduced costs associated with SPD processing, Zimmer Biomet recognized that their primary TJA trays carry a high instrument burden and could be optimized.[21] By reducing instrument trays to only those needed for the case, this efficiency model will reduce total inventory volume, thereby decreasing costs associated with SPD processing of the trays as well as decreasing the time it takes to turn over the OR for satisfaction and retention, improvements in patient the next case. In this study, primary TKA and THA trays were condensed from seven trays each to three trays over the short course of a few months. This resulted in a significant decrease in OR TOT of 19 minutes, which is a comparable reduction to the TOTs mentioned in the previous studies above. Impact of this time-savings was quantified by calculating the cost-savings in the OR and SPD, which was conservatively estimated to be over $250,000 per year based on this single arthroplasty surgeon's case volume. Furthermore, following implementation of this model, the surgeon's caseload was noted to increase from an average of two primary TJA cases per OR day to three primary TJA cases, demonstrating an increase in productivity. The cumulative TOT-saved per day creates the potential for one additional case to be performed per day, which generates additional revenue for the surgeon, department, and hospital that was not accounted for in this analysis.

Overall, the similar gain in OR time we report in this study compared to previous larger-scale strategies in the literature underscores the value of small-scale interventions such as streamlining instrument trays for high-volume procedures like primary TJA to improve OR efficiency. Execution of this model does not require any additional resources or cost, but instead removes waste from the OR following a short period of tray optimization. Therefore, we expect this impact to be sustained indefinitely. An additional benefit of this tray optimization was improved consistency of TOT. This allowed the arthroplasty surgeon and anesthesia teams to foster teamwork and communication, which also contributed to improved TOT. The benefits of this model only have the potential to multiply if hospitals implement this instrument tray optimization for other surgeons as well as combine it with the successful multidisciplinary strategies previously studied.

This study has some limitations, and our findings should be interpreted considering these shortcomings. Given that this study was conducted at a single institution by a single surgeon, studies of larger scale involving multiple orthopaedic surgeons would lead to a more comprehensive cost-savings analysis and enhance generalizability of our findings. Our cost-savings analysis also used an average cost per one minute of OR time and an average SPD processing cost of a single TJA tray identified from studies conducted in California and North Carolina, respectively, and thus, did not account for variation in location costs.[15,16] Therefore, the cost-savings could be even greater than our present calculations. In addition, TOTs were calculated using self-reported times by OR staff, meaning times could be imprecise. We also acknowledge the fact that other factors such as anesthesia preparation time and delays in patient transport can still greatly affect TOT despite the OR being equipped and ready for the procedure. Nonetheless, we hope that this efficiency model can be used as a model for other orthopaedic surgeons who wish to streamline instrument trays and reduce costs. Further studies are needed to explore the true benefits made possible by improving OR TOT, including, but not limited to, improvements in employee satisfaction with OR experience, any additional indirect cost-savings to the hospital, and/or opportunity to increase overall OR case volume.

Conclusion

This study underlines the effectiveness of a streamlined efficiency model aimed at reducing operating room (OR) turnover time (TOT), thereby enhancing overall OR productivity for the benefit of hospitals, patients, and staff. Our research suggests that by refining and consolidating the instrument trays used for primary total joint arthroplasty (TJA), we can diminish OR TOT by an average of 19 minutes. This reduction translates into substantial annual savings exceeding $250,000 in OR and Sterile Processing Department (SPD) operations for a single surgeon's TJA procedures. The efficiency gained also affords the surgeon capacity to perform an additional TJA procedure daily, contributing to increased revenue—this aspect was not included in our financial analysis. If this strategy were to be adopted across various surgical disciplines within a hospital, our projections suggest the possibility of even more significant cost reductions. Additional advantages of lowering OR TOT encompass a boost in the number of OR procedures and enhanced satisfaction among employees and patients alike. Hence, the targeted approach of optimizing surgical instrument trays emerges as a cost-effective and enduring strategy to elevate OR efficiency.

Acknowledgement

N/A

Authors Contribution:
KH mainly wrote the manuscript, performed data collection and the final data analysis. SH significantly contributed to data collection and data analysis. JC also aided in data analysis and writing the manuscript. PG helped in data collection and preliminary data analysis. AS conceived the idea and helped write the manuscript. MLB is the fellowship-trained surgeon who executed the efficiency model using his caseload and was a major contributor in designing the study, writing the manuscript and performing the final data analysis.

Declaration of Conflict of Interest: The author(s) do NOT have any potential conflicts of interest for this manuscript.

Declaration of Funding: The author(s) received NO financial support for the preparation, research, authorship, and publication of this manuscript.

Declaration of Ethical Approval for Study: Ethical approval was obtained prior to conducting this study and was approved by our Institutional Review Board as study ID #23-145 on August 7, 2023.

Declaration of Informed Consent: Informed consent was waived due to the retrospective nature of the study. There is no information (names, initials, hospital identification numbers, or photographs) in the submitted manuscript that can be used to identify patients.

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