Increased OR Efficiency with Surgeon-Managed Orthopaedic Blocks

Rebekah M Kleinsmith MD[1,2]; Kendra Kibble MD[3]; Stephen A Doxey DO[1,2]; Brian P Cunningham MD [1,2]

[1]*Department of Orthopaedic Surgery, Park Nicollet Methodist Hospital, St. Louis Park, MN, USA*
[2]*Department of Orthopaedic Surgery, TRIA Orthopaedic Institute, Bloomington, MN, USA*
[3]*Department of Orthopaedic Surgery, University of Minnesota, Minneapolis, MN, USA*

Objectives: To analyze orthopaedic operative block time efficiency when scheduled by operating suite scheduling time versus a dedicated group of orthopaedic surgeons and clinical leaders.

Design: Retrospective review using data from a metropolitan hospital.

Main Outcome Measurements: Estimates of cost-effectiveness, including incremental cost-effectiveness ratio (ICER) comparisons and cost per quality-adjusted life year (QALY) ratios.

Results: On average, 13.4 ± 3.1 cases were done per day in the four orthopaedic ORs during the post-intervention (surgeon-scheduled) period compared to 11.3 ± 3.2 and 11.6 ± 2.8 in the pre-intervention and post-COVID periods, respectively ($p < 0.001$). Analysis of average percent deviation from scheduled time reveals a significantly lower average deviation during the post-intervention period (17.3 ± 19.3 %) when compared to the pre-intervention and post-COVID periods (18.7 ± 23.8% and 19.7 ± 24.0%, respectively; $p = 0.003$). Additionally, there was a greater-than-expected frequency of cases estimated accurately (within 10% of their actual operative time) during the post-intervention period (959, 45.1%; $p<0.001$).

Conclusions: The present study demonstrates an average increase in the number of orthopaedic cases performed per day with a subsequent decrease in the proportion of after-hours cases with surgeon responsibility for case scheduling.

Level of Evidence: Level IV

Key Words: Operating room efficiency; Surgical case scheduling; Orthopaedic surgery blocks

INTRODUCTION

The utilization and efficiency of surgical operating rooms (ORs) have substantial implications for patient outcomes and health system finances[1]. The operating suite is one of the largest contributors to hospital revenue, accounting for up to 40% of the total revenue[2]. Despite its ability to generate revenue, the cost of running a single OR was reported to be anywhere from $500-$4,000 per hour in 2006, with this value nearly tripling during over-utilized OR time[3]. In the present day, total OR costs are estimated to reach upwards of $36 per minute, or $16 not including professional fees for the surgeon or anesthesiologist[2, 4].

In a time of value-driven healthcare, OR efficiency is paramount. There are many ways to analyze OR efficiency, including percent of OR utilization, on-time starts, turnover time analyses, total caseload, and number of cases started and completed after the standard shift[5]. Orthopaedic surgery, particularly orthopaedic trauma, represents a unique mix of scheduled and add-on cases, requiring frequent last-minute scheduling changes and rendering OR efficiency very difficult[6]. In addition to the implementation of efficiency models such as “lean” and “six sigma”, many operating suites have adopted a block-schedule model, allocating dedicated time to a specific service based on prior OR utilization and caseload [5, 7, 8].

The purpose of this study is to analyze OR efficiency before and after the onset of a surgeon-

managed block. Outcomes of interest include the number of after-hours cases, total case volume, and minutes of OR utilization per day. Secondary outcomes of interest are OR efficiency in the setting of a post-COVID period. We hypothesize that OR utilization and total case volume will increase after the implementation of a surgeon-managed schedule, with a simultaneous decrease in after-hours case starts.

METHODS

At our institution, there are four ORs with block time dedicated to orthopaedic surgery every weekday. Before August 2019, surgery scheduling was the responsibility of the operating suite schedulers with orthopaedic block time available for scheduling up until its release 7 days prior. In August 2019, the responsibility of scheduling orthopaedic operations in the four dedicated orthopaedic rooms was transferred to a cohort of orthopaedic surgeons and clinical leaders. At this time, the utilization of swing rooms was initiated. Surgeons were held accountable for responsible OR utilization by calls when their cases went longer than scheduled during which they were asked for an explanation. The team responsible for scheduling met weekly to discuss scheduling difficulties and proactively looked at surgeon schedules 45 days out for planned time away. If a surgeon was found to have time off on one of their "usual" OR days, another surgeon was assigned the block with plenty of time to cancel or reschedule clinics that would have otherwise taken place. Subsequently, many scheduling liberties were lost with the start of the COVID pandemic, leaving OR schedules back in the hands of the OR suite scheduling team. Swing rooms were maintained; however, the orthopaedic blocks were released to other services 3 days prior if not filled.

Operative suite scheduling information including case start time, case length ("wheels-in" to "wheels out"), number of operations per OR per day, and turnover time were extracted from the health system electronic medical record system and operating suite scheduling software, Epic Op Time (Verona, Wisconsin) for the four orthopaedic ORs from August of 2018 through March of 2023. The study period was divided into three intervention periods according to the party responsible for scheduling. All periods began in August as that was the initiation of the surgeon-managed block schedule and ended in February as that was just before the first shutdown due to the pandemic. Periods were matched by calendar dates (i.e. all were dates August

- February) to control for any seasonal variation in case volume. August 2018 – February 2019 was designated as the preintervention period (cases scheduled by the surgical schedulers), August 2019 – February 2020 was the post-intervention block (orthopaedic surgeons responsible for case scheduling), and August 2021 – February 2022 was the post-COVID block (autonomy of orthopaedic surgeons over OR scheduling being regained after COVID). Each subgroup was divided into months for month-by-month comparative analyses. Weekend cases were excluded from the subgroup analysis.

Operative suite efficiency was analyzed in terms of monthly caseload, number of cases starting after the standard shift end (after 5:00 pm), average OR time per weekday, case time deviation, and OR overutilization in minutes. OR overutilization is defined as the number of minutes after 5:00 pm (the normal scheduled staffed hours) for which a patient is in the OR. Deviation was defined as the absolute value of the estimated (scheduled) case length minus the actual case length. Percent deviation is deviation divided by estimated case length x 100%. Scale variables are expressed as mean ± standard deviation. Categorical variables are expressed as frequency (%). Analyses included chi-squared tests, t-tests, two-proportion z-tests, and ANOVA as appropriate. Kruskal-Wallis rank sum tests were applied in the instance of non-normal distribution of variables. Statistical significance was defined as an alpha value of $p \leq 0.05$. Statistical analyses were performed using Microsoft Excel and Intellectus (Clearwater, FL).

RESULTS

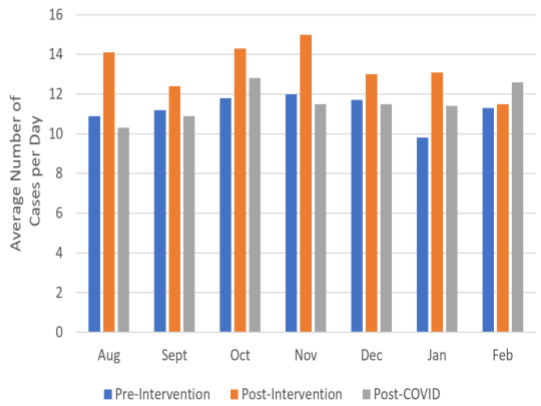
A total of 5,893 orthopaedic cases took place in the study periods. Of these 5,893 cases, 413 (7.0%) took place on weekends and 582 (9.9%) began after the scheduled block. The average number of cases per OR per weekday was 3.0 ± 1.8. The average case length was 117.4 minutes with 18.5 ± 22.3% deviation from the scheduled case length on average. Most cases were longer than their scheduled time (3135, 53.2%).

The post-intervention period, in which surgeons were responsible for case scheduling, had the greatest case volume (2141 cases; 36.3% of all cases). On average, 13.4 ± 3.1 cases were done per day in the four orthopaedic ORs during the post-intervention period compared to 11.2 ± 3.2 and 11.5 ± 2.8 in the pre-intervention and post-COVID periods, respectively ($p < 0.001$) (Figure 1). The average total operative time per day was significantly

Figure 1: Table and graphic representation of the average number of orthopaedic cases per weekday completed in the four orthopaedic operating rooms.

Average Number of Cases per Weekday				
	Pre-Intervention	Post-Intervention	Post-COVID	P-value
Aug	10.9 ± 2.4	14.1 ± 2.0	10.3 ± 2.5	**<0.001**
Sept	11.2 ± 4.0	12.4 ± 3.5	10.9 ± 3.7	0.383
Oct	11.8 ± 2.7	14.3 ± 2.1	12.8 ± 1.8	**0.003**
Nov	12.0 ± 2.9	15.0 ± 3.4	11.5 ± 3.3	**0.004**
Dec	11.7 ± 4.0	13.0 ± 3.7	11.5 ± 2.6	0.336
Jan	9.8±2.9	13.1 ± 2.1	11.4 ± 2.5	**<0.001**
Feb	11.3 ± 2.7	11.5 ± 3.6	12.6 ± 2.1	0.402
Overall	11.2 ±3.2	13.4±3.1	11.5±2.8	**<0.001**

Data represented as mean ± standard deviation
Statistical significance defined as $p \leq 0.05$. Indicated by boldened text.



longer in the post-intervention group at 33.0 ± 7.5 hours than in the pre-intervention and post-COVID groups (27.4 ± 8.6 and 29.1 ± 7.3 hours respectively; $p < 0.001$) (Figure 2). The post-intervention period had proportionately fewer cases starting after hours (200, 9.3%) compared to the pre-intervention and post-COVID periods (10.9% and 9.5% respectively), though this did not reach statistical significance ($p = 0.096$ and $p = 0.827$ respectively). Month-by-month analysis reveals a significant effect of the intervention period on average cases per weekday and average operative time per weekday for August, October, November, and January ($p \leq 0.006$) (Table 1).

Overall, there was no difference in average case length between the three study periods ($p = 0.341$). Analysis of average percent deviation from scheduled time reveals a significantly lower average deviation during the post-intervention period (17.3 ± 19.3 %) when compared to the pre-intervention and post-COVID periods (18.7 ± 23.8% and 19.7 ± 24.0%, respectively; $p = 0.003$). Additionally, there was a greater than expected frequency of cases estimated accurately (within 10% of their actual operative time) during the post-intervention period (959, 45.1%; $p<0.001$).

Figure 2. Line chart representing monthly averages of hours of operating room usage per day in each of the three distinct study periods.

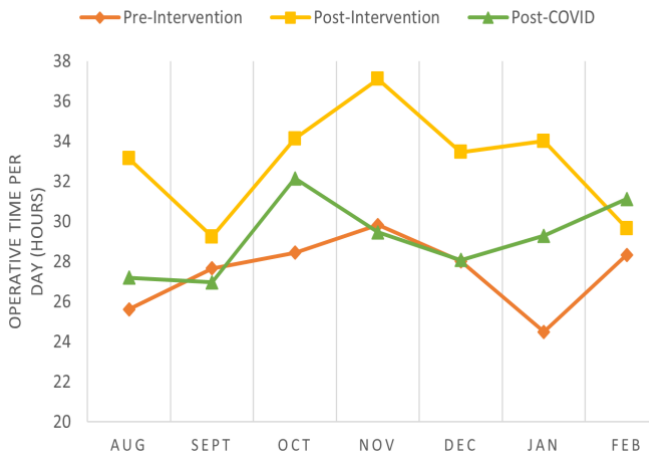


Table 1. Average OR time per weekday (min)

	Pre-Block	Post-Block	Post-COVID	P-value
Aug	1537.3 ± 390.4	1989.0 ± 288.4	1632.3 ± 375.8	**<0.001**
Sept	1659.6 ± 668.4	1755.0 ± 585.2	1617.8 ± 612.5	0.769
Oct	1706.9 ± 424.5	2048.1 ± 305.1	1929.5 ± 275.8	**0.005**
Nov	1790.2 ± 508.1	2226.6 ± 522.9	1767.8 ± 484.7	**0.006**
Dec	1681.1 ± 595.2	2008.1 ± 586.7	1684.6 ± 400.5	0.081
Jan	1470.1 ± 529.3	2041.1 ± 353.4	1757.9 ± 428.3	**<0.001**
Feb	1700.6 ± 489.5	1779.3 ± 592.8	1868.0 ± 340.9	0.555
Overall	1645.9 ± 518.7	1982.5 ± 488.1	1747.6 ± 435.4	**<0.001**

Data represented as mean ± standard deviation

DISCUSSION

This retrospective study aims to analyze operating room efficiency when surgical case scheduling is under the control of orthopaedic surgeons or the surgical suite scheduling team. We hypothesized that operative room utilization (as represented by the total number of operative minutes per day) and case volume would increase as a result of surgeon scheduling responsibility, with a concomitant decrease in after-hours case starts. A total of 614 days with 5,893 orthopaedic cases took place in the study periods. Overall, the average number of cases per day and average operating room utilization per day were significantly increased during the study period in which surgeons were responsible for operative room scheduling. In addition to increased case volume and operative time, cases scheduled during the post-intervention period had a lower average deviation of actual case time from the scheduled case time. There were proportionally fewer after-hours case starts during the surgeon-scheduled study period, though this did not reach statistical significance.

A common target for efficient OR scheduling is increasing scheduled case-length accuracy. Machine learning models developed to predict case length more reliably (within 10% of the actual case length) only do so approximately 30% of the time, with surgeons accurately predicting case length 32% of the time[2]. The present study demonstrates higher accuracy of surgeon schedulers, with 45% of cases being accurately scheduled. The higher accuracy of case length predictions by surgeons likely relates to the surgeon's experience and personal knowledge of their average operative time in conjunction with their understanding of the needs and characteristics. Previous literature demonstrates a significant contribution of patient factors to operative time. For example, patients with class-III obesity can require up to 22% more operative time than patients with a normal BMI [9]. Surgeon knowledge of individual patient factors and their own operative habits contribute to a more accurate prediction of required operative time.

Throughout the study period, there were several positive effects outside of increased OR efficiency regarding both the orthopaedic surgeons and the surgical services team. The specialized scheduling team that was responsible for a small number of ORs allowed for more customizability of OR scheduling with easier access to OR time for surgeons in the instance of last-minute case add-ons. Surgical services benefitted greatly with fewer managerial responsibilities regarding operative suite scheduling and more case completions during the staffed blocks minimizing overtime hours and their accompanying financial burden. All surgeon scheduling calls were fielded by another orthopaedic surgeon, lessening the conflicting burden on the surgical services team.

There are several strengths and weaknesses to the present study. Several surrogates for OR efficiency were utilized to perform comparative analyses between the three discrete study periods, with great agreement between the outcomes of interest. The study took place in a metropolitan hospital with a Level-II trauma designation, which may limit generalizability due to the difference in scope and volume of cases seen in rural settings or at a Level-I academic center. Additionally, the study periods were limited due to the proximity of the onset of the COVID-19 pandemic to the initiation of the scheduling delegation change. Finally, patient factors, clinical outcomes, and hospital length of stay were not analyzed in the present study, though previous literature demonstrates improved clinical outcomes and decreased length of stay with surgical cases performed during the day versus those performed after-hours[10].

CONCLUSION

More efficient use of OR time allows for greater revenues for the health system, more timely surgical intervention for patients, and fewer after-hours cases[3]. The present study demonstrates an average increase in the number of orthopaedic cases performed per day with a subsequent decrease in the proportion of after-hours start cases with surgeon responsibility for case scheduling. The benefits of increased OR efficiency extend beyond the confines of the operating room, demonstrating improved clinical outcomes with daytime cases[3, 10] and positive economic implications for the health system [11, 12]. Creating a team of surgeons to manage operating room scheduling generates more efficient OR utilization leading to positive effects on patients, surgeons, and health systems alike.

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