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REPORTS OF ORIGINAL INVESTIGATIONS

Cost comparison between spinal versus general anesthesia for hip and knee arthroplasty: an incremental cost study

Comparaison des coûts entre la rachianesthésie et l'anesthésie générale pour l'arthroplastie de la hanche et du genou : une étude de coût incrémentielle

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Abstract

Purpose *Wait list times for total joint arthroplasties have been growing, particularly in the aftermath of the COVID-19 pandemic. Increasing operating room (OR) efficiency by reducing OR time and associated costs while maintaining quality allows the greatest number of patients to receive care.*

Methods *We used propensity score matching to compare parallel processing with spinal anesthesia in a block room vs general anesthesia in a retrospective cohort of adult patients undergoing primary total hip arthroplasty (THA) and total knee arthroplasty (TKA). We compared perioperative costs, hospital costs, OR time intervals, and complications between the groups with nonparametric tests using an intention-to-treat approach.*

Results *After matching, we included 636 patients (315 TKA; 321 THA). Median [interquartile range (IQR)] perioperative costs were CAD 7,417 [6,521–8,109], and hospital costs were CAD 10,293 [9,344–11,304]. Perioperative costs were not significantly different between groups (pseudo-median difference [MD], CAD −47 (95% confidence interval [CI], −214 to −130; P = 0.60); nor were total hospital costs (MD, CAD −78; 95% CI, −340 to 178; P = 0.57). Anesthesia-controlled time and total intraoperative time were significantly shorter for spinal anesthesia (MD, 14.6 min; 95% CI, 13.4 to 15.9; P < 0.001; MD, 15.9; 95% CI, 11.0 to 20.9; P < 0.001, respectively). There were no significant differences in complications.*

Conclusion *Spinal anesthesia in the context of a dedicated block room reduced both anesthesia-controlled time and total OR time. This did not translate into a reduction in incremental cost in the spinal anesthesia group.*

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Résumé

Objectif *Les temps d'attente pour les arthroplasties articulaires totales ont augmenté, en particulier à la suite de la pandémie de COVID-19. Une augmentation de l'efficacité de la salle d'opération (SOP) fondée sur une réduction du temps en salle d'opération et des coûts associés, tout en maintenant la qualité, permettrait à un plus grand nombre de patients de recevoir des soins.*

Méthode *Nous avons utilisé l'appariement par score de propension pour comparer en parallèle des traitements par rachianesthésie dans une salle de bloc vs par anesthésie générale dans une cohorte rétrospective de patients adultes bénéficiant d'une arthroplastie totale de la hanche (ATH) et d'une arthroplastie totale du genou (ATG) primaires.*

Nous avons comparé les coûts périopératoires, les coûts hospitaliers, les intervalles de temps en SOP et les complications entre les groupes avec des tests non paramétriques en utilisant une approche d'intention de traiter.

Résultats *Après appariement, nous avons inclus 636 patients (315 ATG; 321 ATH). Les coûts périopératoires médians [écart interquartile (ÉIQ)] étaient de 7417 $ CA [6521 – 8109] et les coûts hospitaliers de 10 293 $ CA [9344 – 11 304]. Les coûts périopératoires n'étaient pas significativement différents entre les groupes (différence pseudomédiane [DM], −47 $ CA (intervalle de confiance à 95 % [IC], −214 à −130; P = 0,60), pas plus que les coûts hospitaliers totaux (DM, −78 $ CA; IC 95 %, −340 à 178; P = 0,57). Le temps sous anesthésie et le temps peropératoire total étaient significativement plus courts pour la rachianesthésie (DM, 14,6 min; IC 95 %, 13,4 à 15,9; P < 0,001; DM, 15,9; IC 95 %, 11,0 à 20,9; P < 0,001, respectivement). Aucune différence significative n'a été observée dans les complications.*

Conclusion *La rachianesthésie dans un contexte de salle de bloc dédiée a réduit à la fois le temps sous anesthésie et le temps total de SOP. Cela ne s'est pas traduit par une réduction du coût différentiel dans le groupe recevant une rachianesthésie.*

Keywords arthroplasty · healthcare cost · regional anesthesia · resource utilization

In 2014–2015, more than 50,000 hip arthroplasties (THA) and more than 60,000 knee arthroplasties (TKA) were performed in Canada at an average cost of CAD 8,737 and CAD 7,779 per patient, respectively.[1,2] These procedures are considered cost-effective with costs per quality adjusted life year (QALY) that compare favorably to other common health interventions (i.e., polypharmacy treatment for cardiac disease prevention).[3,4] Nevertheless, the ability to provide these treatments in Canada is constrained by available resources and funding.[5] Performing joint arthroplasties under spinal anesthesia has a number of potential positive effects. A large meta-analysis including 94 cohort and randomized studies found a reduction in pulmonary, renal, thromboembolic, and infectious complications when patients received spinal anesthesia for THA and TKA compared with general anesthesia.[6] Nevertheless, with over 250,000 patients included in many analyses and with absolute differences in the range of 1–7 per 1,000, the clinical significance of these differences is controversial.[6] Whether one accepts that these differences are clinically meaningful or not, a cost incremental study is warranted. Healthcare funding is a limited resource and therefore subject to opportunity costs.

To reduce delays between cases while waiting for the block to take effect, many institutions have created block rooms where regional procedures can be performed in parallel to multiple operating rooms (ORs). Block rooms offer several advantages when providing regional anesthesia. When compared with general anesthesia, blocks performed in a dedicated block room were associated with reduced OR time, recovery room time, opioid use, postoperative nausea, and anesthesia time, with increased recovery room bypasses and increased numbers of cases per day.[7–12]

To our knowledge, only one study has assessed the difference in cost between spinal anesthesia and general anesthesia for arthroplasty populations.[13] This study involved 40 patients undergoing THA and TKA, but only included anesthesia-specific costs and did not assess complications or total hospital costs.[13] Other efficiency studies consider mainly time or do not consider marginal costs in the context of total costs.[10,11] As opposed to some past studies evaluating efficiency from an induction room serving a single OR,[10–12,14] a block room serves several ORs simultaneously to provide blocks based on varying schedules. Block rooms are typically a separate space with specialized staff and dedicated equipment serving multiple ORs. Therefore, establishment and maintenance of block rooms incur setup and operating costs. The purpose of this study is to determine the direction and magnitude of OR costs, hospital costs, OR time intervals, and complications between spinal anesthesia *vs* general anesthesia for primary hip and knee arthroplasties.

Methods

Enrollment and allocation

This was a retrospective propensity-matched cost-minimization study. We included adult (aged > 18 yr) patients who underwent primary elective THA and TKA from 1 January to 31 December 2016 at the QEII Health Sciences Center in Halifax, NS, Canada. Patient charts were excluded if the patient underwent a revision arthroplasty, urgent/emergent surgery, or bilateral arthroplasties; if other procedures were added; if the patient had a history of joint infection; or if the indication for surgery was a malignancy. Patients who received a spinal anesthetic in the OR were excluded. Patient charts were identified by procedure and date fields in the Innovian® intraoperative record system database (Drägerwerk AG & Co, Lübeck, Germany). Inclusion/exclusion criteria were confirmed by a research coordinator based on a chart review. Patients were divided into two groups: 1) spinal anesthetic performed in the block room, and 2) general anesthesia performed in the OR. This study used an intention-to-treat approach, such that if a spinal anesthetic was converted to a general anesthetic, the patients were analyzed in the spinal anesthesia group.

Block room organization

Our block room is staffed by two anesthesiologists, one anesthesia assistant, one nurse, and one patient attendant over an eight-hour shift. There is capacity for four patients at a time servicing multiple ORs including orthopedic, plastic, vascular, and general surgery lists. Individual ORs notify the block room when the preceding case is nearly done and then again when the preceding patient is leaving the room. The goal is for all surgical regional anesthesia to be achieved and analgesic blocks to be placed prior to the room setup being finished for the next case. In each OR, patients are managed by a staff anesthesiologist. Following the procedure, admitted patients can move from the recovery room to the ward once the spinal begins to recede.

Data linkage

Baseline patient data and complication data were extracted from the hospital electronic medical record by a research coordinator. Once this was complete, the Department Quality Improvement Officer deterministically linked the extracted data to the other hospital data sets (Innovian, Horizon Surgical Manager, Horizon Patient Folder, and Case Costing) using the medical record numbers (MRNs).

Baseline patient data

Baseline patient data were extracted from the anesthesia and nursing preoperative records, including age, sex, body mass index (BMI), and American Society of Anesthesiologists' Physical Status (ASA/PS) classification.[15,16] In cases where patient records were missing an ASA/PS class, one of the authors (J. B.) assigned the ASA/PS class based on the preoperative assessment.

Outcomes

Our costing methodology and reporting follow the criteria established by Graves *et al.*[17] The economic analysis was from a provincial single payer perspective including all hospital costs. Cost estimation was provided from the Nova Scotia Health (NSH) case costing team. Costs were estimated based on micro-costing using data gathered by multiple hospital databases (Electronic Supplementary Material [ESM] eAppendix 1), meaning patient-level resource utilization multiplied by the cost of those resources. Nova Scotia Health case costing does not include physician billing; therefore, anesthesiologist remuneration was estimated based on the wages from the alternative funding plan calculated by the minute. Surgeon remuneration was estimated using billing codes for the included procedures. All costs were calculated in 2016 Canadian dollars (CAD). Perioperative costs included all costs related to the perioperative environment as outlined in Fig. 1.

Figure 1 describes the costs included in the calculation of hospital costs. Use of resources was calculated according to the cost of each resource as per "bottom-up" costing,[18,19] except for facility costs and some staffing costs, which were averaged based on total costs and total number of patients. Laboratory tests, radiologic investigations, and blood products were calculated by the individual test traced to the specific patient. Medications were captured via the central pharmacy. Staffing costs were based on salaries and documented hours assigned to the specific patient (including overtime pay).

Time intervals were obtained from the electronic intraoperative nursing chart. Time intervals of interest are displayed in Fig. 1. Hospital complications were categorized according to the Clavien–Dindo (CD) classification:[20] nonfatal complications were defined as minor (CD level I and II) and major (CD level III and IV), and fatal complications were categorized as CD level V. If a patient experienced more than one complication, the most severe was used for analysis. Spinal failure rates were identified from Innovian. All complications in the recovery room, during the hospital stay, and 30 days following the OR (including outpatient complications) were captured by reviewing each patient's electronic medical record including follow-up clinical notes and emergency room visits.

Statistical analysis

Propensity scores were created based on the procedure (TKA *vs* THA), surgeon, age, sex, BMI, and ASA/PS class. The two groups (spinal *vs* general) were then 1:1 matched based on nearest neighbor using a caliper of 0.2 of the standard deviation of the logit of the propensity score.[21,22]

Univariate comparisons were analyzed by Chi square or Fisher's exact tests for dichotomous outcomes (readmission), Kruskal–Wallis for ordinal outcomes (CD complication class), and Wilcoxon signed rank tests (length of stay [LOS], time intervals, costs). Adjusted median costs were calculated by exponentiating the least squares means of the log-transformed total costs using general linear

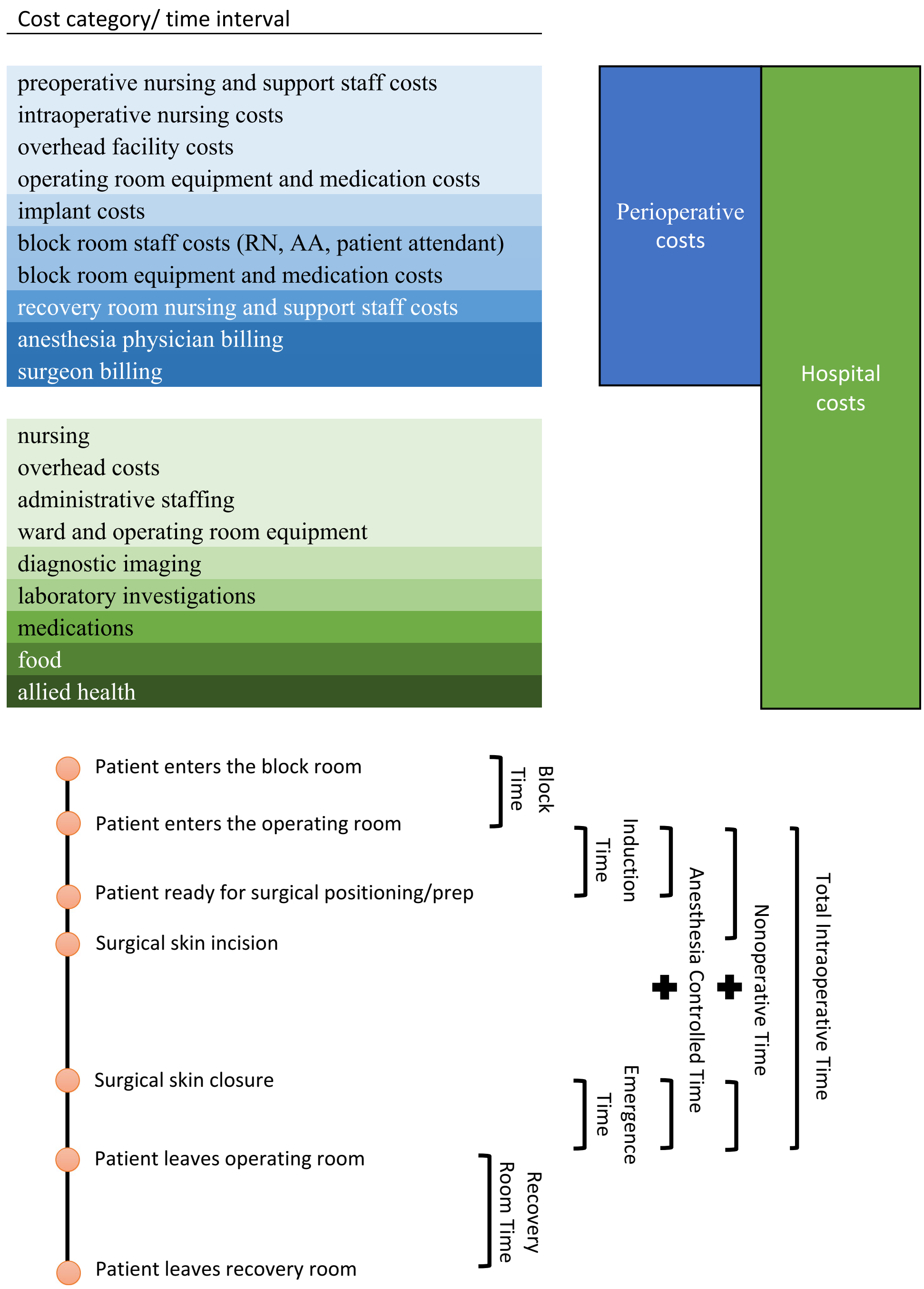

Fig. 1 Categories and subcategories included in the costing model and time intervals. AA = Anesthesia assistant; RN = Registered nurse

models.[23,24] Costs attributable to each adverse event were calculated using a regression-based approach.[25]

A sensitivity analysis was performed to test the robustness of the findings for perioperative costs and total hospital costs. The cost of each resource category (arthroplasty components, nonphysician personnel reimbursement, anesthesia remuneration, OR time, recovery room time, and hospital LOS) was varied while holding all other costs constant. A tornado diagram was plotted to show the variation in cost associated with changing assumptions about each resource.[26] The upper and lower bounds of each resource were varied by 10% from the value at our institution (lower bound = 90%, upper bound = 110%), except for LOS which varied by ± one day. To evaluate the influence of extreme values, we repeated analyses after patients with costs above the 95th and 99th percentile had been removed. Analyses were performed with the use of R software (R Foundation for Statistical Computing, Vienna, Austria).

Table 1 Demographics of patients undergoing primary elective hip and knee arthroplasty before and after propensity score matching

Characteristic	Before matching		*P* value	After matching		*P* value
	Spinal *N* = 454	General *N* = 333		Spinal *N* = 318	General *N* = 318	
Age (yr), median [IQR]	69 [61–76]	65 [58–72]	< 0.001	67 [60–74]	65 [59–72]	0.11
Female, *n*/total *N* (%)	195/454 (43%)	137/333 (41%)	0.66	134/318 (42%)	135/318 (43%)	1.00
BMI (kg·m^{-2}), median [IQR]	29.6 [26.3–33.9]	29.7 [26.6–34.8]	0.36	30.0 [26.3–34.8]	29.8 [26.6–34.7]	0.83
Joint, *n*/total *N* (%)			< 0.001			0.27
Knee	262/454 (58%)	150/333 (45%)		165/318 (52%)	150/318 (47%)	
Hip	192/454 (42%)	183/333 (55%)		153/318 (48%)	168/318 (53%)	
ASA/PS class, *n*/total *N* (%)			0.02			0.32
I	31/454 (7%)	40/333 (12%)		26/318 (8%)	35/318 (11%)	
II	311/454 (68%)	205/333 (62%)		215/318 (68%)	199/318 (63%)	
III	112/454 (25%)	88/333 (26%)		77/318 (24%)	84/318 (26%)	

P values are from either Chi square or Wilcoxon rank sum tests

ASA/PS class = American Society of Anesthesiologists' Physical Status classification; BMI = body mass index; IQR = interquartile range

Sample size estimation

The sample size estimation was based on OR cost estimates for THAs that were supplied by the NSH case costing initiative. We powered the study to detect a change in OR staff/overhead costs of 10%. We initially calculated the sample size for a linear regression model with six covariates. Assuming an alpha error of 5% and a power of 90%, a sample size of 450 patients was required (G*Power 3.1 software[A]). After obtaining data but before the initial analysis, we changed analysis plans, opting for propensity score matching. A *post hoc* sample size calculation (using the initial effect size estimate) found that, for Wilcoxon signed rank tests, a sample size of 268 was necessary to achieve 90% power assuming an alpha error of 0.05.

Results

A total of 1,076 THAs and TKAs were performed at the QEII Health Sciences Center in 2016. Of those, 842 patients met the inclusion criteria. Implausible values for BMI, anesthesia-controlled time, and emergence time were removed. Patients with an ASA/PS score of 4, missing cost data, and surgeons working at our center infrequently were also removed, leaving 787 patients for analysis. Of these, 454 patients received spinal anesthesia and 333 patients received general anesthesia. Seven surgeons contributed to the sample with case volumes ranging between 40 and 179 arthroplasties. Propensity score matching was able to match 318 patients receiving spinal anesthetic with 318 patients receiving general anesthesia. Demographics of unmatched and matched patients are displayed in Table 1. There was good balance of propensity scores between the treatment groups based on visual inspection of the jitter plot (ESM eAppendix 2) and histograms.

Median [interquartile range (IQR)] perioperative costs were CAD 3,721 [3,374–4,074] excluding orthopedic implant components and CAD 7,417 [6,521–8,109] including components. Perioperative costs were not significantly different for spinals performed in the block room *vs* general anesthesia (Table 2). None of the sensitivity analyses changed this nonsignificant difference. Varying the total OR time had the greatest effect on the median difference (Fig. 2).

Median [IQR] total hospital costs were CAD 10,293 [9,344–11,304] excluding the cost of readmissions and CAD 10,347 [9,404–11,370] including readmissions. Total hospital costs were not significantly different between general and spinal anesthesia (Table 2). The result was similar when the cost of readmissions was included. This result was similar when high-cost outliers were removed by excluding patients with hospital costs above the 95th or 99th percentile. Median [IQR] LOS in hospital was 3.0 [2.0–4.0] days. There was no significant difference in LOS between anesthetic types ($P = 0.62$). None of the sensitivity analyses changed this significant difference. Varying the LOS had the greatest effect on the median difference.

Median [IQR] total intraoperative time was 113.8 [90.0–132.8] min, of which anesthesia-controlled time accounted for 17.6 [11.9–26.9] min. Median recovery room

[A] *Buchner A, Erdfelder E, Faul F, Lang AG.* G*Power: statistical power analyses for Mac and Windows. Available from URL: https://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/gpower (accessed June 2020)

Table 2 Breakdown of operating room and hospital costs by cost category

Outcome	Spinal	General	*P* value
Perioperative costs (CAD), median [IQR]			
OR nursing, support staff, overhead	1,953 [1,644–2,279]	2,200 [1,851–2,536]	< 0.001
Implant components	3,705 [2,149–4,300]	3,936 [2,149–4,407]	0.80
Block room*	281 [231–349]	0 [0–0]	N/A
Recovery room	415 [318–555]	375 [286–510]	0.02
Physician fees*	996 [940–1,036]	1,034 [970–1,080]	< 0.001
Total perioperative	7,455 [6,514–8,182]	7,422 [6,468–8,116]	0.60
	Pseudo-median difference -47 (95% CI, -214 to 130)		
Out-of-OR hospital costs (CAD), median [IQR]			
Inpatient nursing, support staff, overhead	2,119 [1,867–2,760]	2,139 [1,565–2,762]	0.60
Diagnostic imaging	70 [65–70]	70 [65–70]	0.53
Laboratory	71 [56–104]	72 [58–112]	0.94
Pharmacy	134 [99–199]	128 [95–187]	0.29
Food	108 [103–144]	108 [72–144]	0.64
Allied health	50 [44–118]	52 [42–127]	0.78
Total hospital	10,221 [9,373–11,362]	10,239 [9,250–11,146]	0.57
	Pseudo-median difference -78 (95% CI, -340 to 178)		
Time intervals (min), median [IQR]			
Block time	51.2 [40.5–66.1]	0 [0–0]	< 0.001
Anesthesia-controlled time	12.3 [9.5–16.3]	27.1 [21.7–33.3]	< 0.001
	Pseudo-median difference 14.6 (95% CI, 13.4 to 15.8)		
Induction time	5.3 [3.4–8.5]	15.0 [12.0–18.0]	< 0.001
Emergence time	6.5 [5.0–8.0]	11.0 [8.5–15.0]	< 0.001
Nonoperative time	24.4 [21.5–28.4]	41.1 [35.0–47.6]	< 0.001
Intraoperative time	107.1 [85.1–122.9]	122.3 [96.9–140.3]	< 0.001
	Pseudo-median difference 16.1 (95% CI, 11.3 to 20.9)		
Recovery room time	145.2 [109.1–195.9]	131.3 [101.3–183.9]	0.02
	Pseudo-median difference 11.0 (95% CI, 1.4 to 20.1)		

*Physician fees for physicians working in the block room are captured in the cost category "block room"

CAD = 2016 Canadian dollars; 95% CI = 95% confidence interval; IQR = interquartile range; OR = operating room; N/A = not applicable

time was 137.6 [103.4–189.0] min. Anesthesia-controlled time was significantly less for spinal than general anesthesia (Table 2; Fig. 3), and the same was true for induction time, emergence time, and nonoperative time. Total intraoperative time was also significantly less with spinal *vs* general anesthesia (Table 2; Fig. 3). Nevertheless, recovery room time was longer for patients receiving a spinal *vs* a general anesthetic (Table 2; Fig. 3).

Of the 454 patients receiving spinal anesthetic, 29 (6.4%) had a failed spinal and went on to receive a general anesthetic. Overall, 353 (44.9%) patients had a complication; however, 289 (36.7%) were CD level I, including bradycardia, tachycardia, hypotension, desaturation, or anemia, and did not need a change in management. Another 54 patients (6.9%) experienced a CD level II complication including anemia requiring transfusion, hemodynamic instability requiring pharmacologic intervention, thromboembolic complications, and cardiorespiratory complications. Six patients (0.8%) experienced CD level III complications requiring invasive intervention, three patients (0.4%) required intensive care, and one patient (0.1%) died in hospital. There was no significant difference in complications between spinal and general anesthesia groups (χ^2 trend, P = 0.82; Fig. 4). Twelve patients (1.5%) were readmitted to hospital. Four patients were readmitted in each of the groups in the matched data set. Adjusted median costs for each level of complication using matched data were CAD 9,907 for no complications, CAD 10,520 for CD level I complications, CAD 12,978 for CD level II complications, CAD 10,721 for CD level III complications, and CAD 44,802 for CD level IV

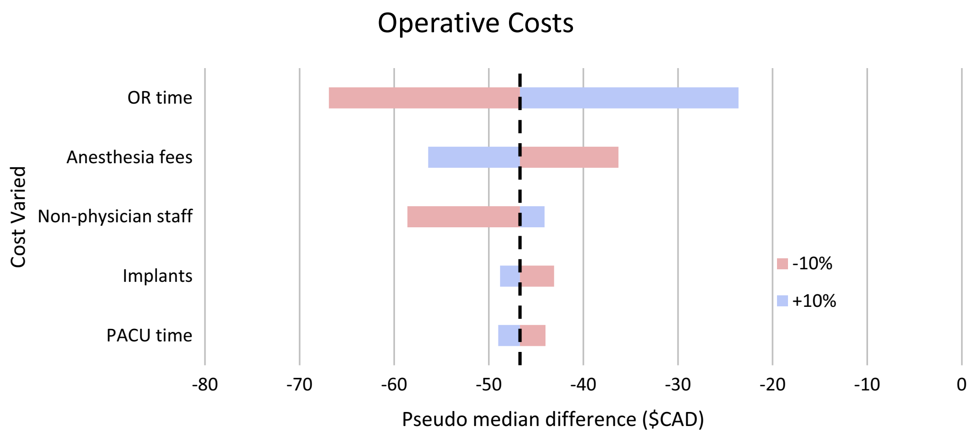

Fig. 2 Tornado plots showing the effect of sensitivity analyses on differences in perioperative costs. The pseudo-median difference is produced by Wilcoxon signed rank test in R as an estimate between the two groups (spinal *vs* general). Pseudo-median difference represents the median of the difference between a sample from each group rather the difference in medians of each group. The vertical dotted line between the bars represents the base rate for the difference in operating room costs between spinal and general anesthesia. The length of each bar signifies the change in cost difference if the value each resource listed on the y-axis increased or decreased by 10%. CAD = 2016 Canadian dollars; OR = Operating room; PACU = postanesthesia care unit

complications. Median [IQR] costs attributable to complications in the unmatched sample while controlling for joint, surgeon, age, sex, BMI, and ASA/PS class were CAD 570 [556–586] for CD level I complications, CAD 2,868 [2,801–2,952] for CD level II complications, CAD 4,897 [4,703–5,053] for CD level III complications, and CAD 13,270 [13,196–13,905] for CD level IV complications.

Discussion

Parallel processing is one of the many methods of improving OR efficiency that have been recommended in the past.[27] A number of past studies have shown a reduction in OR time when instituting a block room, assuming a corresponding reduction in perioperative costs, yet failed to directly calculate the costs between groups.[28–32] The main strengths of this study are a patient-level bottom-up cost calculation that directly compares costs between groups and a robust sensitivity analysis that accounts for variation in healthcare costs and practices.

We found no difference in OR costs despite a reduction in anesthesia-controlled time and total OR time. Analysis of cost subcategories found that the main cost reduction in the spinal group was due to reduced personnel costs in the OR. This was offset by increased costs related to personnel in the block room and recovery room. This is likely due to three reasons. First, there are several added costs associated with running a dedicated block room—the largest being personnel costs. If the number of staff in the block room were reduced, it is possible that reduction in OR time would offset the added cost of block room staff. Second, this study only considered spinal anesthetics with a relatively short onset time and analgesic blocks. Including surgeries that require blocks with longer onset times, such as brachial plexus blocks, may have favored the block room by increasing the effect of parallel processing. Third, the time in the recovery room was longer in the spinal group. With shorter acting spinal anesthetics or policies that would allow the patients to move to the floor before the spinal fully recedes, recovery room costs may be reduced.

We included all hospital costs in this analysis recognizing that regional anesthesia has the potential to influence more than just OR efficiency through a change in complication rates or earlier ambulation and discharge. We also found no differences in overall hospital costs between the two groups. The out-of-OR costs were very similar between groups and accounted for a relatively small portion of the total cost compared with the perioperative costs. Nevertheless, it is difficult to say what the magnitude of influence would be had there been more complications in one group over the other. As mentioned above, a systematic review comparing spinal to general anesthesia for THA and TKA found reductions in several complications.[6] Nevertheless, these were all rare events so our sample size was insufficient to produce a difference in event rates. In our study, we found that the median attributable costs for complications requiring intervention were CAD 2,892–4,904 and that complications requiring a critical care intervention added CAD 13,051 in median attributable costs. Incremental cost analysis involves

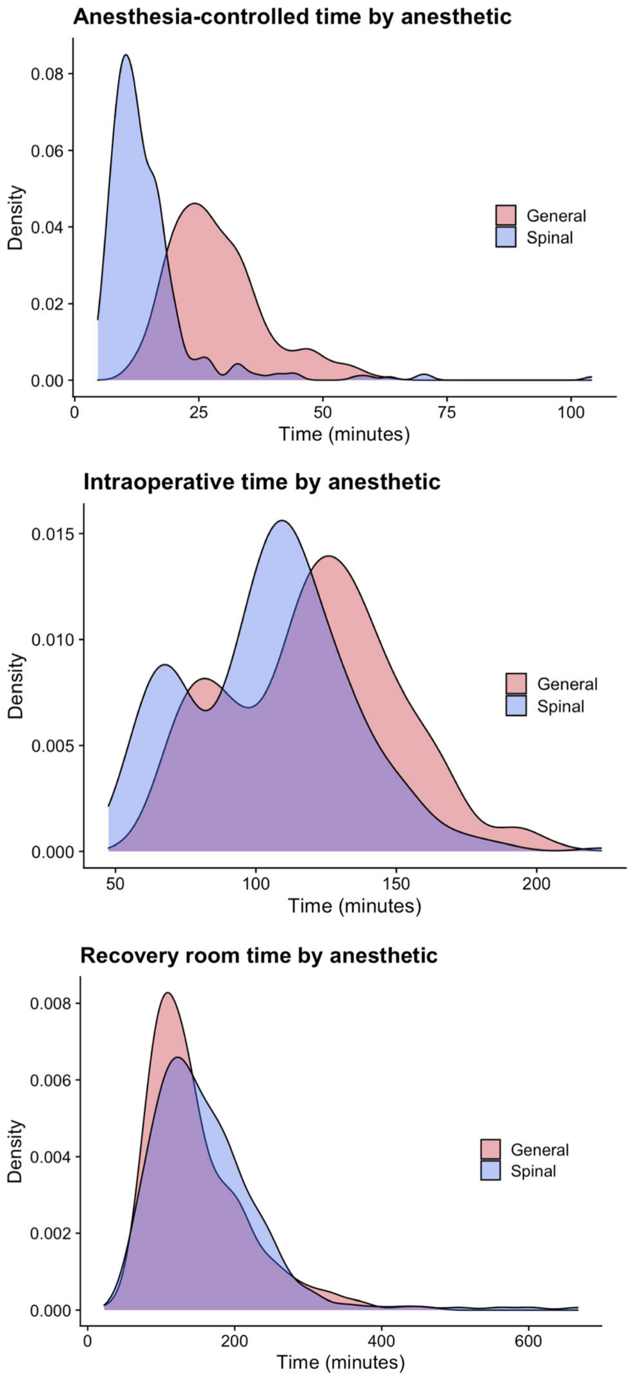

Fig. 3 Perioperative time intervals compared between spinal and general anesthesia displayed as kernel density estimates

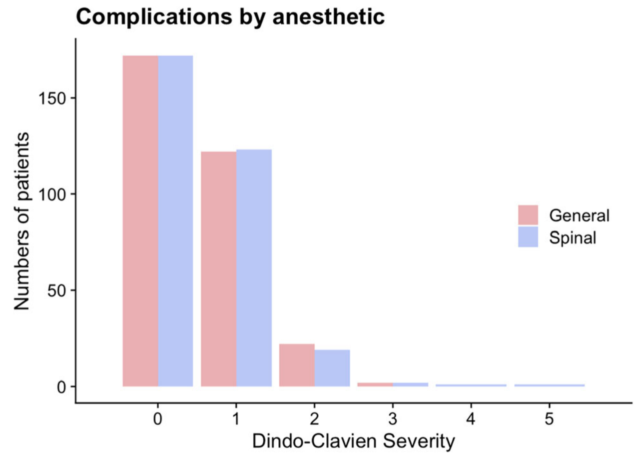

Fig. 4 Complication rates by anesthetic type categorized by Clavien–Dindo severity classification

calculating the difference in costs between two interventions. Since the clinical consequences to our patients are more important than the costs to the system, incremental costs are normally presented in healthcare as incremental cost-effectiveness ratios (ICERs).[33] We would have presented our findings as ICERs if there had been a significant difference in 30-day clinical outcomes. Since there was no significant difference in clinical outcomes, we compared costs directly using incremental costs.

In this study, we found that both anesthesia-controlled time and total OR time were reduced in the spinal anesthesia group. The question of whether this represented a clinically meaningful reduction relies on three metrics: additional cases completed, reduced case cancelation, and reduced overtime hours. It is possible that with approximately four to five arthroplasties being completed in a day that saving 16 min per case would reduce both cancelations and overtime hours. Nevertheless, this study was not designed to capture additional cases or case cancelation rates. Instead, it was meant to complement other studies that have described those benefits. When past studies compared surgical blocks performed in the OR *vs* a dedicated block room, anesthesia time was reduced, an additional case per day was allowed, postoperative pain was reduced, and the number of late starts was reduced when blocks were performed in the block room.[31,32] A recent study was able to show an additional total joint arthroplasty per day with the introduction of a block room.[28] Similar to our study, a recent meta-analysis showed that block rooms were associated with a reduction in anesthesia-controlled time of 10.4 min, which resulted in an increase of 1.7 cases per day.[34] None of these studies included a comprehensive cost analysis. Our study showed that the benefits of a block room did not increase either perioperative or hospital costs; and the incremental cost comparison was not substantially affected by varying resources within 10% of base rates.

The largest cost trade off in this study was the cost of personnel in the OR, the block room, and the recovery room. The main assumption is that all staff are always used efficiently. Cost reduction relies on parallel processing to reduce overall intraoperative time. If the OR staff remained idle while waiting for the spinal to take effect, the potential cost reduction would be squandered. No ambulatory arthroplasties were included as this was not common practice at the time the data were collected. Recovery room bypass was not allowed for admitted patients but early transfer to the floor was allowed once the spinal started to regress. Policies that would allow recovery room bypass would have further improved the incremental cost for spinal anesthesia in our setting given that recovery room times were significantly longer in the spinal group.[35]

The cost and time differences in OR will be influenced by the block room organization, overall OR coordination, room turnover, and patient flow.[10,36,37] We could not account for all of the variability between healthcare systems, but the series of one-way sensitivity analyses (represented as a Tornado plot) gives our readers some idea of the relative impact of cost variability on the incremental cost analysis.[38] This study is most applicable to the Canadian context given that costs of equipment and reimbursement of personnel vary between countries.[39] This variability limits transferability, making it a difficult but not impossible to interpret the findings in other countries.[40,41] Whether a block room will be cost-effective depends on the costs of the block room and the volume of cases. It has been argued that medium-sized hospitals are most likely to benefit from a block room.[42] In a Canadian context, this would mean that regional centers are more likely to benefit than community hospitals. Our study shows that, even with heavy block room staffing and an average ten cases receiving blocks per day, perioperative costs are not increased.

Limitations

The total cost of the block room staff was averaged across all patients for this study, which may have overestimated the associated costs for patients receiving spinal anesthetics. Another limitation is that, although we were able to match groups based on several demographic and procedural data, we were unable to capture frailty due to lack of reliable data. More THA patients receiving general anesthesia had associated greater cost of implant components than THA patients receiving spinal anesthesia in a block room did. This difference may partially offset the costs of the block room staff in the spinal group; however, when analyses were rerun excluding the cost of components, there was no difference in cost between the groups. The cost of overtime OR hours was included in our study for the index cases; however, we were unable to account for the cost of the overtime work of nonindexed cases or to capture the number of canceled cases. This is because a case later in the day might have been the case canceled and therefore was not included in our data set.

Conclusion

Spinal anesthesia in the context of a dedicated block room reduced both anesthesia-controlled time and total OR time. Perioperative costs and total hospital costs were not significantly different between groups. Providing spinal anesthesia in the context of a block room decreases OR time without increasing costs.

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