SCIENTIFIC ARTICLE

Direct Variable Cost Comparison of Monitored Anesthesia Care Versus Wide Awake Local Anesthesia No Tournique Carpal Tunnel Release: A Time-Driven Activity-Based Costing Analysis

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Purpose Time-driven activity-based costing (TDABC) provides a more accurate and granular estimation of direct variable costs compared with traditional accounting methods. This study used TDABC to quantitatively compare the same-day facility costs of open carpal tunnel release (CTR) performed under monitored anesthesia care (MAC) versus wide awake local anesthesia no tourniquet (WALANT).

Methods We retrospectively identified 474 unilateral CTR (182 MAC and 292 WALANT) performed at an orthopedic specialty hospital between 2015 and 2021. Itemized facility costs were calculated using a TDABC algorithm. Patient demographics, surgical characteristics, and itemized costs were compared between those treated under MAC (MAC-CTR) and WALANT (WALANT-CTR). Multivariable regression was performed to determine the independent effect of MAC on true facility costs.

Results Total facility costs were $170 higher in MAC-CTR compared with WALANT-CTR ($652 vs $482). Monitored anesthesia care−CTR cases had higher personnel costs ($537 vs $394), likely because of higher surgery personnel ($303 vs $185) and postanesthesia care unit personnel costs ($117 vs $95). Monitored anesthesia care−CTR cases also had higher supply costs ($119 vs $81). When controlling for demographics and comorbidities, MAC-CTR was independently associated with an increase in personnel costs by $150.65 (95% CI, $131.09−$170.21), supply costs by $24.99 (95% CI, $9.40−$40.58), and total facility costs by $175.66 (95% CI, $150.18−$201.09) per case.

Conclusions Using TDABC, MAC-CTR was found to be 35% more costly to the facility compared with WALANT-CTR. Notably, WALANT-CTR facility costs presented here do not include additional cost savings from anesthesiologist service fees or preoperative laboratory clearance required for MAC-CTR surgeries. To reduce costs related to CTR surgery, greater efforts should be made to reduce the number of intraoperative personnel and maximize the use of WALANT-CTR in an outpatient setting. *(J Hand Surg Am. 2024;■(■):1.e1-e8. Copyright © 2024 by the American Society for Surgery of the Hand. All rights are reserved, including those for text and data mining, AI training, and similar technologies.)*

Type of study/level of evidence Economic and Decision Analysis II.

Key words Carpal tunnel release, carpal tunnel syndrome, cost analysis, hand surgery, time-driven activity-based costing, value-based care.

Online Exclusive

VALUE-BASED PRACTICES HAVE become essential in modern medicine amid the rapid rise in health care costs.[1] An in-depth understanding of resource utilization is needed in order to develop effective cost-saving strategies. In the context of elective hand surgery, growing variability in costs

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coupled with declining reimbursement rates have underscored the importance of accurate cost accounting in an effort to maximize value.[2]

Previous cost analyses performed for common hand surgeries have used top-down accounting estimates such as cost-to-charge ratios, relative value units, and reimbursement rates.[3–5] Although widely applied because of their availability, traditional accounting measures have been recently shown to lack accuracy and detail in the calculation of true facility costs.[6,7] These previously used costing metrics can be substituted for by more granular methodologies such as time-driven activity-based costing (TDABC), which uses time-driven road mapping to assess personnel and supply costs specific to each patient's episode of care.[7–13] As such, direct costs to the practice, including personnel, medications, and supplies per unit of time can be accounted for using this approach, providing a more granular and precise calculation of patient- and surgery-specific costs. Additionally, in contrast to traditional methods that rely on charges set by payers or relative value units multiplied by conversion factors set by the Center for Medicare & Medicaid Services, TDABC allows facilities and providers to measure costs specific to a surgical procedure. Nonetheless, despite its widespread use in total joint arthroplasty literature and among health policy leaders,[8,10,12–15] few studies have applied TDABC to explore the costs related to elective hand surgery.[11,16–18]

Carpal tunnel release (CTR) is an extremely common elective hand surgery with an annual volume of more than 500,000 cases in the United States.[19,20] Although historically performed under general anesthesia or monitored sedation, there has been a growing trend in the United States to perform CTR with the patient awake and using only local anesthesia.[21] Current literature describes wide awake local anesthesia no tourniquet (WALANT) CTR as a safe alternative to traditional anesthesia, with similar rates of patient satisfaction compared with CTR performed under monitored anesthesia care (MAC).[22–24] Given the similarities in outcomes for WALANT- and MAC-CTR as well as the increasing demand for this surgery, determining the most cost-efficient approach for CTR remains essential in ensuring value-driven care. To our knowledge, no studies have used TDABC to compare the costs of elective CTR performed under these two common forms of anesthesia (ie, WALANT-CTR vs MAC-CTR).

The purpose of our study was, therefore, to use TDABC to quantitatively compare same-day direct variable facility costs of open CTR performed under WALANT and MAC anesthesia in a large contemporary cohort of patients. The study aimed to provide a more accurate cost assessment of same-day facility costs pertaining to WALANT- and MAC-CTR. The overarching goal of this study was to present actionable data on the stages within each patient care cycle where increased costs can occur. We hypothesized that WALANT-CTR would result in significantly lower facility costs when compared with MAC-CTR.

METHODS

Following institutional review board approval, we retrospectively identified 474 patients who underwent unilateral, isolated, open CTRs (182 MAC-CTR and 292 WALANT-CTR) by three hand surgery fellowship-trained orthopedic surgeons at an orthopedic specialty hospital between 2015 and 2021. All MAC-CTR and WALANT-CTR cases were performed in an operating room (OR) setting because of the lack of procedure rooms at the orthopedic specialty hospital. All surgeries were outpatient, same-day surgeries, and no patients were kept overnight. Cases that were excluded from this study included bilateral cases, revision cases, and cases performed in conjunction with other surgeries.

The TDABC algorithm used was developed by a third-party vendor (Avant-garde Health) and used to calculate specific facility costs, including supply and personnel costs.[11–13,25] Personnel comprised all clinical and nonclinical staff involved in each step of the patient care cycle, including physicians, anesthesia technicians, surgical technicians, nurses, pharmacists, and transporters (Fig. 1). Staff salary data used for personnel cost were collected from the Human Resources department. To collect data for all phases of the patient's care, timestamps from electronic medical records, self-reporting of unobserved documentation time gathered from interviews with hospital personnel, direct observation with assistance from the third-party consultant, and multidisciplinary validation of process maps through meetings with staff and management were used. The collected data were then analyzed to produce time equations and calculate precise personnel costs for each patient.[8] Since anesthesiology personnel involved in this study were not paid directly by the facility, direct anesthesiology personnel costs including anesthesiologist and nurse anesthetist service fees were not included in the analysis. Anesthesiologist personnel costs are often variable contractual agreements between each institution and an individual and/or

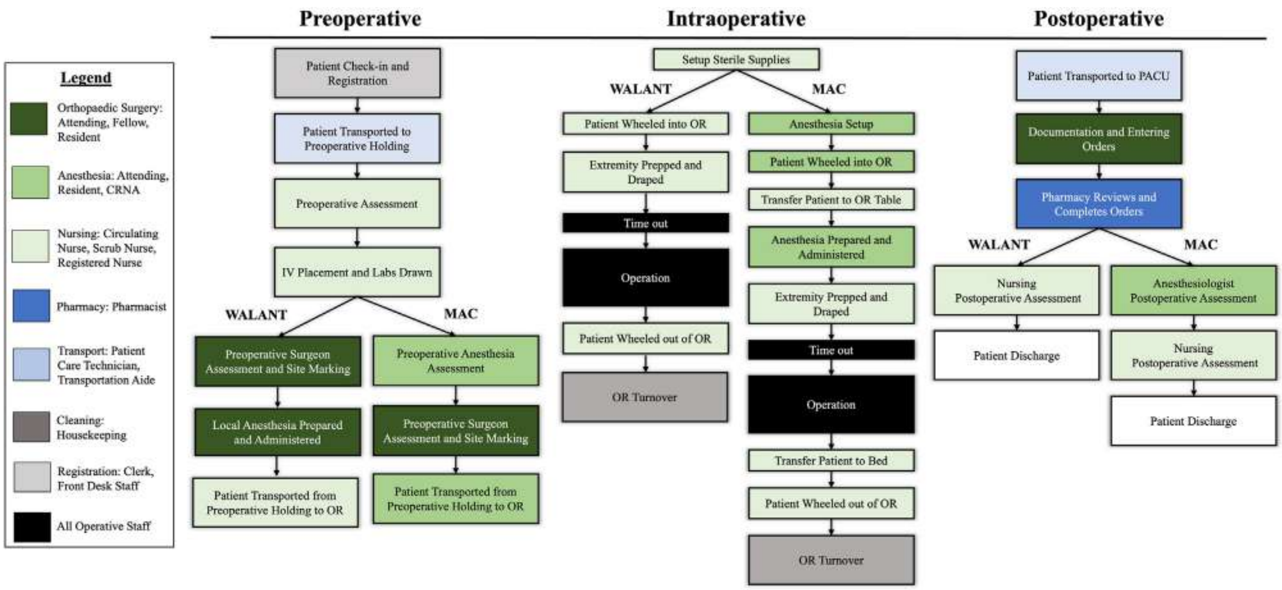

FIGURE 1: Flow diagram outlining the process map of carpal tunnel release operating day including preoperative, operative, and postoperative requirements. Each box represents activities and arrows indicate sequencing. Each stage of the operating day was the same, regardless of endoscopic or open technique performed intraoperatively. Box colors correspond to personnel involved with each stage in the patient care cycle (see legend provided).

private practice anesthesiology group (eg, flat service fee per annum plus bonuses vs purely volume-based). These negotiations are not contingent on the surgical procedure (in this case, CTR). Nevertheless, to account for direct facility anesthesia costs, all anesthetic charges were estimated using conversion factors, base units, and time units provided by the Centers for Medicare & Medicaid Services (ie, Anesthesiologist Cost = Conversion Factor × [Base Units + Time Units]). Time spent completing tasks such as documenting, note-taking, and other non–direct patient-related activities was not included.

Only times related to direct patient care encounters on the day of the surgery were considered in these equations. The analysis was classified based on the timeline of care on the day of surgery, including preoperative, intraoperative OR, and postanesthesia care unit (PACU) costs. Preoperative time was defined as the time from check-in to the time the patient entered the OR (wheels-in); intraoperative/OR time was defined as the time the patient entered the OR to the time the patient exited (wheels-out); and postoperative time was defined as all time spent in the surgery center after being wheeled out of the OR and into the PACU. Supply costs included medications, implants, and other supplies including surgical drapes, dressings, and syringes. Costs not associated with patient care, such as utility bills, sterile processing, and facility maintenance, were not included in the analysis.

Patient demographics such as age, race, sex, body mass index, ethnicity, Elixhauser comorbidity index (ECI), and American Society of Anesthesiology (ASA) classification were collected in an institutional database. Preoperative Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaires and preoperative Short-Form-12 mental and physical scores were routinely collected before surgery and at 1 year after surgery. Surgical data including the type of anesthesia (eg, general, MAC, local, and regional block), surgical time, and PACU-to-discharge time (min) were queried from an institutional database. Two patient cohorts were established based on anesthesia type: MAC-CTR and WALANT-CTR. Monitored anesthesia care–CTR patients received MAC sedation plus local anesthetics. Monitored anesthesia care–CTR patients who received preoperative regional blocks were excluded from the analysis. Surgical time was further subdivided into wheels-in to incision time, incision to closure time and closure to wheels-out time. Severe complications necessitating readmission within 30 days of the index surgery were analyzed to further evaluate postoperative costs.

All patient demographics, comorbidity scores, facility costs, and complications were compared between MAC-CTR and WALANT-CTR groups. Categorical variables were compared using Pearson chi-square or Fisher exact tests, and continuous variables were compared using independent samples *t*

TABLE 1. Univariate Analysis of Patient and Surgical Characteristics*

Variable	All Patients	MAC	WALANT	*P* Value
Age (y)	67 ± 13	63 ± 13	69 ± 13	<.05†
Sex				.059
Male	180 (39)	60 (33)	120 (42)	
Female	285 (61)	120 (67)	165 (58)	
Race				<.05†
White	357 (77)	127 (71)	230 (81)	
Non-White	108 (23)	53 (29)	55 (19)	
Ethnicity				.596
Hispanic	51 (11)	18 (10)	33 (12)	
Non-Hispanic	414 (89)	162 (90)	252 (88)	
Smoker				.185
Yes	63 (18)	109 (79)	185 (84)	
No	294 (82)	29 (21)	34 (16)	
BMI	31 ± 7	31 ± 6	31 ± 7	.715
ECI	0.6 ± 0.8	0.7 ± 0.9	0.5 ± 0.8	<.05†
ASA score	44 (19)	41 (23)	3 (6)	<.05†
Preoperative SF-12 physical	39 ± 10	39 ± 10	40 ± 11	.426
Preoperative SF-12 mental	53 ± 10	52 ± 11	54 ± 9	.468
Preoperative DASH score	39 ± 23	42 ± 23	37 ± 23	.084

BMI, body mass index; SF-12, short-form 12.
*Data are represented as mean ± STD or N (%).
†*P*-value reaching statistical significance of $P < .05$.

tests and Mann-Whitney U-tests. Univariate logistic regression was used to identify all variables with an association value of $P < .20$. Controlling for all variables that met this association value, multivariable regression analyses were then performed to assess the independent effect of MAC versus WALANT anesthesia on overall facility costs. Statistical significance was set at $P < .05$.

RESULTS

Patients who received MAC anesthesia were younger (63 ± 13 vs 69 ± 13 years, $P < .05$) and more likely to be of non-White race (29% vs 19%, $P = .05$; Table 1). On average, MAC-CTR patients also had higher ECI (0.7 ± 0.9 vs 0.5 ± 0.8, $P < .05$) and were more likely to have ASA scores >2 (23% vs 6%, $P < .05$; Table 1). However, there was no significant difference in preoperative DASH scores or preoperative PF-12 physical and mental scores ($P > .05$). All patients were discharged home after their outpatient surgery, and there were no complications or readmissions within the 30-day postoperative period in either group.

The primary cost driver for both MAC- and WALANT-CTR were surgery-related personnel costs (46% vs 39%, respectively; Fig. 2). The median total facility cost was $170 higher in MAC-CTR compared with WALANT-CTR ($652 vs $482, $P < .05$; Table 2). The MAC-CTR group had higher median total personnel costs ($537 vs $394, $P < .05$), with significant differences in surgery personnel costs ($303 vs $185, $P < .05$) and PACU personnel costs ($117 vs $95, $P < .05$; Table 2). Median anesthetic charges were $114 (range: $97−$152) for MAC-CTR cases. Higher median total supply costs for MAC-CTR were the result of higher implants costs ($4 vs $3, $P < .05$), medication costs ($10 vs $0, $P < .05$), and other supply costs ($96 vs $77, $P < .05$; Table 2). Additionally, MAC-CTR surgeries had longer total surgical time (27 vs 25 min, $P < .05$) and longer PACU-to-discharge time (65 vs 27 min, $P < .05$; Table 2).

Multivariable analysis controlling for patient age, sex, race, smoking status, ECI, ASA, and preoperative DASH scores revealed that MAC-CTR was independently associated with an increase in personnel cost by $150.65 (95% CI, $131.09−$170.21), supply costs by

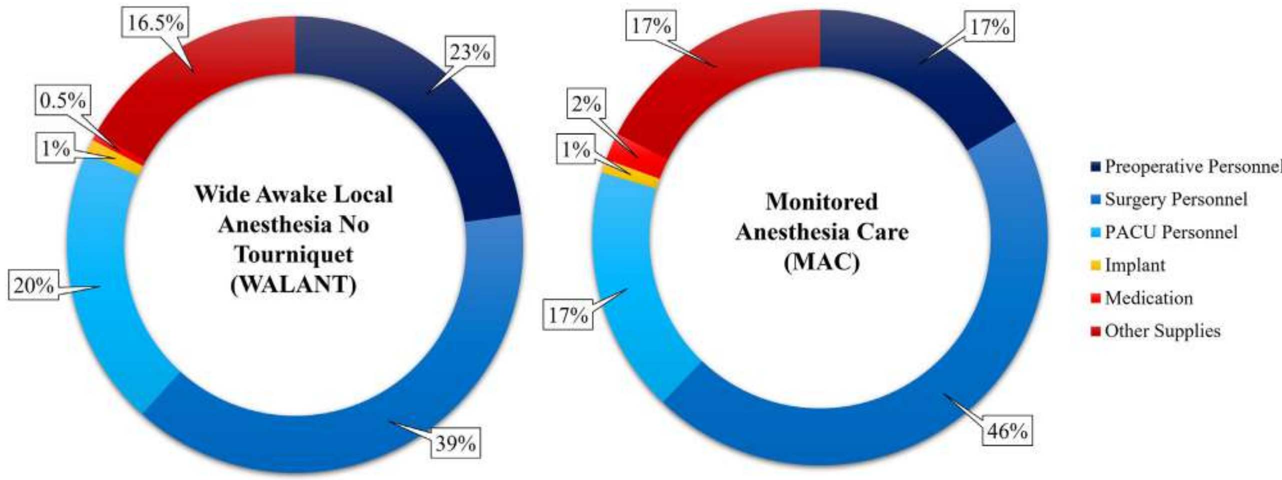

FIGURE 2: Pie chart illustrating cost categories as a percentage of total facility costs for WALANT versus MAC.

TABLE 2. Cost and Time of WALANT and MAC CTR*

Variable	Total Cohort	MAC	WALANT	*P* Value
Total cost ($)	524 (367; 1,054)	652 (532; 1,054)	482 (367; 936)	<.05†
Total personnel cost ($)	427 (304; 712)	537 (454; 712)	394 (304; 550)	<.05†
Preoperative personnel cost	113 (113;113)	113 (113; 113)	113 (113; 113)	1
Surgery personnel cost	216 (117; 479)	303 (217; 479)	185 (117; 339)	<.05†
PACU personnel cost	100 (0; 189)	117 (87; 189)	95 (0; 138)	<.05†
Total supply cost ($)	86 (31 ;480)	119 (31; 480)	81 (62; 428)	<.05†
Implant cost	4 (0; 25)	4 (0; 25)	3 (0; 16)	<.05†
Medication cost	0 (0; 74)	10 (0; 50)	0 (0; 74)	<.05†
Other supply costs	81 (27; 443)	96 (27; 443)	77 (53; 419)	<.05†
Total OR time (min)	25 (14; 51)	27 (16; 51)	25 (14; 46)	<.05†
Wheels-in to incision	13 (1; 30)	14 (7; 30)	12 (1; 30)	<.05†
Incision to closure	10 (6; 26)	9 (6; 26)	10 (6; 23)	.159
Closure to wheels-out	2 (0; 9)	2 (0; 9)	2 (0; 6)	<.05†
PACU-to-discharge time (min)	25 (0; 186)	65 (14; 186)	27 (0; 100)	<.05†

*Data are represented as median (range).
†*P*-value reaching statistical significance of $P < .05$.

$24.99 (95% CI, $9.40−$40.58), and total facility costs by $175.66 (95% CI, $150.18−$201.09) per case (Table 3).

DISCUSSION

As reimbursement rates for elective hand surgeries continue to decline, accurate identification of major cost drivers has become increasingly important for maintaining an efficient and sustainable practice.[2] For private practice physicians (ie, those not practicing within a fee-for-service institution), it is even more imperative to understand the financial implications of their care. Existing studies have used various costing methods such as claims charges, cost to payer, and reimbursement rates to determine the costs of CTR performed under WALANT versus alternative forms of anesthesia (eg, general, MAC, and axillary brachial plexus block).[26−30] The majority of these studies found WALANT-CTR to be less costly, with total savings dependent on the type of instrumentation used and provider-specific charge per unit (ie, conversion factors).[26,27,29,30] These traditional methods of estimating facility costs have well-established limitations in accuracy and were often found to overestimate procedural costs.[8] Moreover,

TABLE 3. Multivariable Logistic Regression for Associations Between MAC and Itemized Costs*

Variable	Cost (95% CI)	*P Value
Total facility cost ($)	175.66 (150.18−201.09)	<.05†
Personnel cost ($)	150.65 (131.09−170.21)	<.05†
Supply cost ($)	24.99 (9.40−40.58)	<.05†

*Multivariable regression controlling for patient age, sex, race, smoking status, ECI, ASA score, and preoperative DASH scores.
†P-value reaching statistical significance of $P < .05$.

these cost accounting strategies often lack the granularity necessary to pinpoint the exact stage(s) within each patient care cycle wherein resources are under- or over-used. In contrast, TDABC algorithms provide actionable data for implementing cost-saving strategies by using time-specific procedural process maps and equations to accurately measure the costs across each stage of surgical care.[31] In this study, we performed a TDABC analysis to quantitatively compare the direct variable costs related to CTR performed under MAC sedation versus WALANT at a high-volume orthopedic specialty hospital and identify where exactly in the care cycle increased costs were accrued.

The study found that MAC-CTR was 35% more expensive to the facility and independently associated with a $176 increase in total facility cost per patient. Previous studies have described a wide variation in cost savings, ranging from $139 to $641 per WALANT-CTR case.[26,27,30] It is highly plausible that these cost differences have been inflated when assessed using traditional costing metrics, because of their overreliance on fluctuating conversion rates. Moreover, the previous studies also included costs pertaining to CTR performed under general anesthesia,[26,27,30] which has been previously established as an independent factor for high direct variable CTR cost.[11] In terms of personnel costs, MAC-CTR was significantly more expensive than WALANT-CTR because of required anesthetic charges, increased total OR time, and longer PACU-to-discharge time. Despite not accounting for externally contracted anesthesiology services (which compensate attending anesthesiologists a flat rate per case in addition to a time-based reimbursement), the present study still found that anesthetic charges alone had a substantial impact on CTR facility costs. It is therefore important to acknowledge that the increased surgery costs for MAC-CTR rely heavily on the need for anesthesiologists and other anesthesia personnel, additional medication and supply costs, and longer PACU-to-discharge time.

Although the present study suggests that personnel cost is the major cost driver for CTR surgeries, the effort of reducing personnel salary and limiting necessary patient contact time is a complex task. From an intraoperative perspective, MAC-CTR performed in an ambulatory surgery center generally requires a hand surgeon, anesthesiologist, certified registered nurse anesthetist (CRNA), and a circulating nurse. In contrast, WALANT-CTR does not require anesthesiologists or CRNAs and requires only the hand surgeon, surgical technician or scrub nurse, and circulating nurse. If performed in office, even less personnel can be expected, as the circulating nurse can be substituted for by a medical assistant.[17] From a PACU perspective, MAC sedation requires a more thorough and lengthy postoperative assessment, as patients must be able to meet numerous postsedation requirements (eg, patient recovery, ability to ambulate, and ability to urinate) prior to discharge. This was evident from the present study, as we found that MAC-CTR patients stayed in the hospital for a median of 65 minutes after surgery, compared with 25 minutes in WALANT-CTR. By implementing WALANT-CTR, PACU and overall hospital time can be significantly reduced, resulting in lower facility costs per patient care cycle. In addition, WALANT-CTR does not require preoperative testing or clearance[27] and can be performed in office or in procedure rooms, which further decreases the cost of CTR care.[17] With this information, an effort to maximize the use of WALANT-CTR can allow providers and facilities the opportunity to improve practice sustainability and generate substantial cost savings. An additional step toward cost reduction is the transfer of WALANT-CTR care from hospital or ambulatory surgery center ORs to clinic or ambulatory procedure rooms.[17]

This study has several limitations. First, data were collected from three surgeons at a high-volume, orthopedic specialty hospital; hence, the generalizability of these findings is unknown. The findings provided are most applicable to private practice physicians and/or facility owners who would most benefit from reducing costs to improve margins and practice sustainability and, therefore, may not be generalizable to a fee-for-service physician at an academic institution. Nevertheless, salaried physicians may still hold leadership positions within hospitals or health care systems where it is part of their fiduciary duty to optimize costs for the institution they are serving. Although costs are institutional, negotiated between the hospital and payor, cost studies still provide valuable insights on the potential cost variations between different clinical practices (in this case, WALANT-CTR vs MAC-CTR). Additionally, the study was a retrospective chart review with inherent biases. There are other limitations regarding the TDABC analysis that should also be acknowledged. Specifically, the study only included costs that were directly related to patient care and excluded indirect costs such as sterile processing, insurance costs, and utility bills. As described by Pathak et al,[32] there lacks a standardized approach for handling indirect costs across TDABC studies. As such, there exists great variability in how and when indirect costs are incorporated into TDABC analyses. Consequently, when compared with traditional accounting methods (eg, reimbursement rates) that account for these costs, our results may seem to underestimate the total costs associated with CTR surgeries. Although no metric can perfectly determine the direct costs of any surgery, TDABC has been proposed as a more accurate method in the calculation of true facility costs. Of note, TDABC studies not only provide insight into institutional costs but also serve as a quality improvement tool for facilities, highlighting inefficiencies and facilitating cost reduction. In addition, the present TDABC analysis did not include cost capacity rates for each personnel type, and we were therefore unable to include these data. Furthermore, any patients with a postoperative complication that occurred after the 30-day postoperative period, as well as those who sustained a minor complication that did not require readmission, were not included in the analysis. However, it should be noted that most major complications of CTR occur within the first 30 days after the surgery.[31] Moreover, as anesthesiology personnel were paid externally from our facility, granular costs for anesthesiology personnel could not be described. Therefore, the present findings must be interpreted within this context as the results underestimate the true personnel cost differences across WALANT- and MAC-CTR. Finally, it must be acknowledged that value-based care is defined by the relationship between outcomes and cost. Although existing studies have demonstrated similar outcomes between MAC- and WALANT-CTR, the present study did not consider clinical outcomes. As such, future studies integrating TDABC and postoperative subjective and objective clinical outcomes are warranted.

CONFLICTS OF INTEREST

No benefits in any form have been received or will be received related directly to this article.

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