Arthroplasty Today 16 (2022) 242–246

Contents lists available at ScienceDirect

Arthroplasty Today

journal homepage: http://www.arthroplastytoday.org/

Original research

Total Joint Arthroplasty at a Novel "Hyperspecialty" Ambulatory Surgical Center With Extended Care Suites is as Safe as Inpatient Arthroplasty

Graham S. Goh, MD, Taylor D'Amore, MD, P. Maxwell Courtney, MD, William J. Hozack, MD, Chad A. Krueger, MD *

Rothman Orthopaedic Institute at Thomas Jefferson University, Philadelphia, PA, USA

ARTICLE INFO

Article history:
Received 1 March 2022
Received in revised form
26 April 2022
Accepted 6 May 2022
Available online 23 June 2022

Keywords:
Outpatient
Ambulatory
Knee arthroplasty
Hip arthroplasty
Outcomes
Safety

ABSTRACT

Background: New "hyperspecialty" ambulatory surgical centers (HASCs) have been introduced to deliver safe and cost-efficient care, allowing patients to spend additional nights in an extended care suite before discharge. This study compared the 90-day complications and readmissions of total joint arthroplasty (TJA) at an HASC and inpatient TJA at a tertiary hospital.

Methods: We retrospectively reviewed 1365 primary, unilateral, TJAs (658 total hip arthroplasty, 707 total knee arthroplasty) performed at 4 HASCs in 2017-2021. Following their outpatient procedure, patients were discharged to an extended care suite staffed full-time by nurses and physical therapists. These patients were matched 1:1 with 1365 inpatient TJAs (628 total hip arthroplasty, 737 total knee arthroplasty) based on demographics, joint, and American Society of Anesthesiologists (ASA) score. Ninety-day complications and readmissions were compared.

Results: The mean age was 60.0 ± 9.8 years and 59.4 ± 8.1 years in the inpatient and outpatient groups, respectively ($P = .106$). There was no difference in ASA≥3 patients (16.4% vs 17.7%; $P = .387$) and operative time (86.9 ± 31.8 vs 88.7 ± 27.9 minutes; $P = .118$). Five patients (0.4%) in the outpatient group were transferred to an acute hospital. When comparing 90-day outcomes between the inpatient and outpatient groups, there was no difference in pulmonary embolism (0.1% vs 0.0%; $P = .317$), mechanical complications (0.3% vs 0.7%; $P = .165$), periprosthetic joint infections (0.5% vs 1.1%; $P = .092$), or readmissions (1.2% vs 1.5%; $P = .513$). A subgroup analysis of ASA≥3 patients yielded similar findings.

Conclusions: Patients undergoing outpatient TJA at a novel HASC had similar complication and readmission rates as those undergoing TJA at a tertiary hospital. Based on these data, such facilities seem appropriate for the care of outpatient TJA patients with ASA<4.

Introduction

The transition toward value-based health care and removal of total joint arthroplasty (TJA) from the Medicare Inpatient-Only list has spurred the growth of outpatient TJA [1]. This paradigm shift has been enabled by recent advances in surgical techniques, multimodal analgesia regimens, and perioperative protocols [2,3]. It is currently estimated that at least half of all TJA procedures will be performed in Ambulatory Surgery Centers (ASCs) on an outpatient basis by the year 2026 [4–6].

Traditional ASCs encompass either multispecialty or single-specialty (eg, only orthopaedics) surgery, with postdischarge care occurring in the home environment. A new development in the field of outpatient TJA is the emergence of "hyperspecialty" ASCs (HASCs) [7], which focuses only on total hip arthroplasty (THA) and total knee arthroplasty (TKA). In this model, patients are not discharged from the ASC to home, rather to an adjacent extended care facility containing suites in which the patient stays for 2 nights while being supported by nurse practitioners and physical therapists. Other elements of this model include an expanded patient engagement program (starting when the patient schedules the

* Corresponding author. Rothman Orthopaedic Institute at Thomas Jefferson University, 925 Chestnut Street, Philaelphia, PA 19107, USA. Tel.: +1 267 339 7813.
E-mail address: chad.krueger@rothmanortho.com

https://doi.org/10.1016/j.artd.2022.05.005

surgery until 1-year postoperatively), standardized business operations and facility designs to improve efficiencies, and evidence-based protocol-driven care pathways to optimize clinical outcomes. Ultimately, it is hoped that these features will lead to favorable outcomes at a predictable and lower cost, in an environment that enhances the patient experience. While there is a growing body of literature reporting the outcomes of outpatient TJA performed at hospital-owned outpatient departments and traditional ASCs [8–14], no studies have investigated the safety of outpatient TJA performed at HASCs.

The purpose of this study was to compare the 90-day safety outcomes and resource utilization in patients undergoing outpatient TJA at an HASC as compared to those undergoing inpatient TJA at a tertiary hospital. We hypothesized that modern perioperative protocols implemented at the HASC would enable outpatient TJA to be performed as safely as inpatient TJA performed at a standard tertiary hospital.

Material and Methods

Patient cohort

This retrospective, propensity-matched, cohort study was approved by an institutional review board. A total of 1365 consecutive primary, unilateral TJAs (658 THA, 707 TKA) were performed at 1 of 4 HASCs between April 2017 and January 2021. Patients in the HASC group underwent propensity score matching (PSM) in a 1:1 ratio with 1365 patients who underwent primary, unilateral TJAs (628 THA, 737 TKA) at a tertiary level one academic center during the same period ("inpatient group"). Matching was based on age, sex, body mass index (BMI), joint, and American Society of Anesthesiologists (ASA) score. Exclusion criteria were revision surgery, simultaneous bilateral procedures, and primary TJA for tumor or fracture indications. Patients were able to choose where they felt most comfortable for surgery as both the HASC and inpatient facilities accepted commercial insurance during the study period. Patients with ASA 4, coagulation disorders, severe cardiorespiratory disease, or cardiac stenting within 2 years were deemed unsuitable to undergo surgery at the HASC. All patients completed 90-day follow-up. The mean age was 68.2 ± 12.2 years, and 39.3% were female.

HASC model

The key elements of this value-based surgical care program are fourfold. First, there is a comprehensive patient engagement program, which is initiated by a nurse navigator (NN) as soon as the patient schedules for surgery. The role of the NN is to educate the patient about the facility and the program, as well as to provide guidance throughout the entire care process, extending until a year after surgery. Second, evidence-based protocol-driven integrated and individualized care pathways are crafted by the NN to help each patient meet their unique recovery goals, with emphasis placed on patient optimization. These protocols continue through the surgery and the first 2 postoperative days to create a safe and pleasant episode of care. Third, the HASC facility is designed with joint replacement needs specifically in mind. In the recovery area immediately after the TJA procedure, patients are guided to meet established milestones, typical of an ASC, that would qualify them to be discharged home. Discharge criteria from the ASC included the ability to ambulate 100 feet in the postoperative anesthesia care unit, tolerate food and water, and void without difficulty and pain and nausea should be well controlled. The next step represents an important difference from a standard ASC: all patients are offered discharge to an adjacent extended care suite where the planned length of stay is 1 to 2 nights, although they are allowed to leave the suites at any time as they would have already met criteria for ASC discharge prior to checking in at the suites. Patients are educated on the benefit and value of staying in the suites, which plays an integral component in being successful in the outpatient total joint program. As such, while this stay was *offered* and not *required*, in this study, all patients chose to continue their planned stay in the suites following same-day discharge from the ASC. No patients were discharged home immediately after the procedure. These suites are modeled after luxury hotel rooms and staffed full-time by nurses and physical therapists. In these "Stay Suites," patients are guided to meet daily recovery milestones that have been clearly outlined preoperatively by the NN. Extensive education for the patient and caregiver(s) is provided prior to home discharge. The patient-navigator partnership (including daily phones and 24-hour access to the NN) extends to 1-year postoperatively, thus ensuring accessible and continuous self-care and education for patients.

Outcome variables

Patient demographics, comorbidities, and operative details were compared between the groups. Operative efficiency metrics such as operative time and total operating room (OR) duration were recorded. Safety outcomes including patient transfers from the HASC to an acute hospital, major complications within 90 days, and readmissions within 90 days were routinely captured and stored in an institutional database. Resource utilization was assessed using suite length of stay (for the HASC group) and hospital length of stay (for the inpatient group), as well as discharge disposition (home, skilled nursing facility, or inpatient rehabilitation). The aforementioned outcome variables were prospectively tracked by a team of orthopaedic NNs throughout the 90-day period [15], allowing us to identify patients who presented at a different facility among the affiliated health systems, thus maximizing capture rate.

Statistical analyses

A power analysis was performed. To determine a 2.5% difference in 90-day complication rates between the 2 groups, a sample size of 1230 patients per group would be necessary to ensure 80% power at an alpha of 0.05. The 2 groups were matched for age, sex, BMI, joint and ASA score using PSM [16]. Nearest-neighbor matching was used. A standardized mean difference (SMD) for each covariate was examined, with an SMD of 10% considered to be suggestive of covariate balance. Patient characteristics and outcome variables were compared between the groups using independent samples t-tests or Mann-Whitney U tests for continuous variables, depending on normality as determined by Kolmogorov-Smirnov testing. Chi-square tests were used for categorical variables. Statistical analyses were performed using SPSS 20.0 (SPSS Inc., Chicago, IL) software package. A P-value of $< .05$ was used to define statistical significance.

Results

A total of 1365 HASC TJAs were matched with 1365 inpatient TJAs from the tertiary center using 1:1 PSM. There was no difference in age, sex, BMI, ASA, or diabetic status between the groups (Table 1). The quality of PSM was considered balanced as the SMDs for each covariate did not exceed 10% (Supplementary Fig. 1). The mean age was 59.4 ± 8.1 years in the outpatient group and 60.0 ± 9.8 years in the inpatient group ($P = .106$). The proportion of patients with BMI ≥35 (19.7% vs 21.7%; $P = .202$), BMI ≥40 (5.9% vs 4.9%; $P = .237$), ASA ≥3 (17.7% vs 16.4%; $P = .387$), or diabetes

Table 1
Demographics and comorbidities of the cohort (n = 2730).

Variable	Inpatient TJA (n = 1365)	Outpatient TJA (n = 1365)	*P*-value
Age	60.0 ± 9.8 (19-87)	59.4 ± 8.1 (25-87)	.106
Sex			.908
Female	740 (54.2%)	737 (54.0%)	
Male	625 (45.8%)	628 (46.0%)	
BMI (kg/m^2)	30.7 ± 5.5 (15-58)	30.4 ± 5.8 (17-53)	.155
<35	1069 (78.3%)	1096 (80.3%)	.202
≥35	296 (21.7%)	269 (19.7%)	
ASA class	2.1 ± 0.5 (1-3)	2.1 ± 0.5 (1-3)	.905
<3	1141 (83.6%)	1124 (82.3%)	.387
≥3	224 (16.4%)	241 (17.7%)	
Diabetes	113 (8.3%)	138 (10.1%)	.112
Joint			.250
THA	628 (46.0%)	658 (48.2%)	
TKA	737 (54.0%)	707 (51.8%)	

TJA, total joint arthroplasty; BMI, body mass index; ASA, American Society of Anesthesiologists; THA, total hip arthroplasty; TKA, total knee arthroplasty.
Data presented as mean ± standard deviation (range) or cell count (%).

(10.1% vs 8.3%; $P = .112$) also did not differ between the inpatient and HASC groups, respectively.

Mean operative time ($P = .118$) and total OR duration ($P = .340$) were similar between the groups (Table 2). Mean length of stay in the extended care suites for the HASC group was clinically similar, although statistically different, to the mean hospitalization stay for the inpatient group (1.8 ± 0.3 days vs 2.1 ± 2.0 days, respectively; $P < .001$), and a higher percentage of patients were discharged to home (100% vs 98.3%; $P < .001$). A higher percentage of patients stayed for 2 days or less in the HASC group compared to the inpatient group (95.6% vs 59.6%; $P < .001$).

Five patients (0.4%) in the HASC group were transferred to a larger hospital for postoperative care. Two patients were transferred due to postoperative hip dislocation in the postoperative anesthesia care unit. One patient had a posterior THA and required a revision THA for the acute dislocation, while the other had anterior THA and underwent close reduction. One patient was transferred for acute respiratory distress. Two patients had possible cardiac events that lead to transfer: 1 patient had chest pain (ultimately due to gastroesophageal reflux) and another patient had transient ST depressions on the postoperative ECG (but ultimately did not require any coronary intervention).

When comparing 90-day complications between the HASC and inpatient groups, there was no difference in mechanical complications including periprosthetic fractures, stiffness requiring manipulation and dislocations (0.6% vs 0.3%; $P = .387$), venous thromboembolism (0.0% vs 0.1%; $P = 1.000$), or periprosthetic joint infection (0.2% vs 0.5%; $P = .343$) (Table 3). Similarly, there was no difference in 90-day readmission rates between the inpatient and HASC groups (1.5% vs 1.2%; $P = .513$). A subgroup analysis of patients with ASA ≥3 yielded similar findings (Table 4). No perioperative mortality occurred in this study.

Table 2
Operative efficiency and resource utilization (n = 2730).

Variable	Inpatient TJA (n = 1365)	Outpatient TJA (n = 1365)	*P*-value
Operative time (mins)	86.9 ± 31.8	88.7 ± 27.9	.118
Total OR duration (mins)	127.1 ± 38.5	125.8 ± 31.7	.340
Transfers to acute hospital	–	5 (0.4%)	–
Length of stay in hospital/suites (d)	2.1 ± 2.0	1.8 ± 0.3	**<.001**
≤2	808 (59.2%)	1300 (95.6%)	**<.001**
>2	557 (40.8%)	60 (4.4%)	
Discharge disposition			**<.001**
Home	1342 (98.3%)	1365 (100%)	
Skilled nursing facility	20 (1.5%)	0 (0%)	
Inpatient rehab	3 (0.2%)	0 (0%)	
Readmissions within 90 days	17 (1.2%)	21 (1.5%)	.513

TJA, total joint arthroplasty; OR, operating room.
Data presented as mean (standard deviation) or cell count (%).
Bold values indicate statistical significance ($P < .05$).

Table 3
Perioperative complications (n = 2730).

Variable	Inpatient TJA (n = 1365)	Outpatient TJA (n = 1365)	*P*-value
Mechanical complication	4 (0.3%)	8 (0.6%)	.387
Periprosthetic fracture	3 (0.2%)	3 (0.2%)	
Stiffness	0 (0%)	3 (0.2%)	
Dislocation	1 (0.1%)	2 (0.1%)	
Venous thromboembolism	1 (0.1%)	0 (0%)	1.000
Periprosthetic joint infection	7 (0.5%)	3 (0.2%)	.343
All-cause mortality	0 (0%)	0 (0%)	1.000

TJA, total joint arthroplasty.
Data presented as cell count (%).

Discussion

The incidence of outpatient TJA is expected to increase [4–6]. Recent literature has focused on ASCs as a viable alternative to traditional hospital outpatient models [17], although research remains relatively sparse. One novel development in the field has been the introduction of HASCs [7]. While these centers are purported to be safe and efficient settings for joint replacement surgery, no studies have evaluated the perioperative outcomes and resource utilization of outpatient TJA in this new model of care. The major finding of our study is that matched patients undergoing outpatient TJA at a novel HASC had similar complication and readmission rates as those undergoing inpatient TJA. Further, we found that patients treated in this novel ASC environment were more likely to be discharged directly home after surgery.

Multiple studies investigating the safety of outpatient THA and TKA have reported comparably low complication and readmission rates [2,18–21]. While several systematic reviews have concluded that outpatient TJA can be performed safely in select patients [3,22], it is important to note that the majority of studies were performed in hospital outpatient departments, which have inpatient observation units for ambulatory patients, 24/7 emergent care, as well as access to other medical specialty services. Attention has now shifted to TJA performed at freestanding ASCs as a safe and viable alternative to inpatient TJA or outpatient TJA at hospital outpatient departments [8–14,23–25]. This trend has accelerated with the advent of value-based reform and bundled payment models [26,27], and over 200 ASCs in 2017 were reported to be performing outpatient arthroplasty compared to 25 in 2014 [28]. While several noncomparative studies of freestanding ASCs have been published [8–12,14], very few studies have compared the results of outpatient TJA at these centers and inpatient TJA at traditional hospitals [13,23–25], and most were limited to administrative claims data [13,23]. Using the Truven MarketScan database, Kimball et al. compared a group of 863 outpatient TKAs with a matched group of 863 inpatient TKAs, noting that the outpatient group had a similar rate of major complications but a significantly lower rate of minor complications (2.8% vs 5.8%) and a trend toward lower 90-day readmissions (5.1% vs 7.3%) [23]. However, the authors included a heterogenous cohort of TKA performed at an ASC or outpatient hospital for analysis. Carey et al. analyzed the same database using a risk-adjusted matched cohort of near-elderly (age 55 to 64 years) inpatients and ASC patients, concluding that both THA and TKA patients had lower 90-day readmission rates, while postsurgical complications were similar for TKA patients and lower for THA ASC patients [13]. To our knowledge, the present study is 1 of the

Table 4
Ninety-day complications and readmissions in patients with ASA ≥3 (n = 465).

Variable	Inpatient TJA (n = 224)	Outpatient TJA (n = 241)	*P*-value
Mechanical complication	1 (0.4%)	1 (0.4%)	1.000
Venous thromboembolism	0 (0%)	0 (0%)	1.000
Periprosthetic joint infection	1 (0.5%)	3 (0.2%)	.352
Readmissions	5 (2.2%)	9 (3.7%)	.421
All-cause mortality	0 (0%)	0 (0%)	1.000

ASA, American Society of Anesthesiologists class; TJA, total joint arthroplasty.
Data presented as cell count (%).

largest comparing the outcomes of matched patients undergoing TJA performed at a freestanding ASC or tertiary hospital. Consistent with earlier findings, we did not observe any difference in 90-day complication or readmission rates between the groups. Although 5 patients required transfer to an acute hospital, no patients suffered any major medical complications and no perioperative mortality occurred. ASCs often have limited resources to diagnose and treat medical complications if a patient's condition deteriorates in the perioperative period [5]. This not only requires careful selection of patients but also necessitates evidence-based perioperative protocols and close monitoring by multidisciplinary teams. When taken together with the published data, the current findings lend support to the overall safety of outpatient TJA at freestanding ASCs.

Another important finding was that a substantial proportion of patients (18%) who underwent TJA at the HASC had an ASA class of 3, which was high compared to most other ambulatory TJA practices [9,29]. Indeed, Kingery et al. noted that only 35.7% of ASA 3 patients were in fact eligible for surgery at a freestanding ASC [30]. In our subgroup analysis of ASA 3 patients, no increased incidence of complications or readmissions was observed in the outpatient group. These findings not only reiterate the safety of outpatient TJA at freestanding ASCs but also suggest that a subset of ASA 3 patients should not be deemed ineligible for surgery in the ambulatory setting. ASA 3 has traditionally been associated with a higher incidence of readmissions following ambulatory surgery [31,32], which in turn increases the episode of care costs and disincentivizes these centers from offering surgery to these patients. In traditional fee-for-service practices, only low-acuity patients would be offered the chance to undergo joint replacement surgery at ASCs and would typically spend 2-6 hours recovering at the facility before being discharged home [5]. This truncated recovery period often requires precise perioperative pathways to facilitate safe and prompt discharge to home within the allotted time. Notwithstanding, there are still several predictable events that could occur in the perioperative period which can predispose to delayed discharge [33]. HASCs are designed to handle routine as well as complex joint procedures, allowing patients who are not ready to return home to stay in extended care suites for close monitoring and postdischarge education by nurses and physical therapists [34–36]. While careful patient selection could account for the comparable 90-day outcomes for the entire HASC cohort, it is also possible that the integrated care pathway and education-focused recovery suites as part of the HASC model could have mitigated the increased risk for complex patients undergoing TJA in the ambulatory setting, highlighting the success of this new model of care delivery.

One important consideration of outpatient TJA is the degree of resource utilization since this influences the overall cost of care and the value created by freestanding ASCs. Due to the limitations of existing administrative database studies [13,23], very few studies to our knowledge have analyzed these metrics in comparison to traditional hospitals. In a recent study on 281 THAs and 242 TKAs performed at an ASC, Yang et al. found that the rates of readmission, emergency room visits, and unplanned office visits were lower in the outpatient group, although this did not reach significance due to the small sample size studied [25]. In addition to comparable readmission rates, the present study found that the length of stay in the recovery suites was significantly lower than the hospitalization stay in the inpatient group, and there was a 10-fold decrease in the number of patients who stayed beyond the planned two-night stay in the recovery suites compared to the number who stayed for more than 2 nights in the hospital (4% vs 41%). All outpatients were discharged to home after their stay in the extended care suits, whereas 1.7% of inpatients required additional care at inpatient rehabilitation and skilled nursing facilities. Overall, it is possible that the sound surgical technique, evidence-based anesthetic and perioperative protocols [37], early ambulation with physical therapy guidance [38], extended recovery time in the care suites, and close follow-up by NNs [35,36] as part of the HASC model could have led to a shorter length of stay while maintaining comparable 90-day complication and readmission rates.

There are several limitations. First, this was a retrospective review of prospectively collected data. Second, patients in the outpatient and inpatient group were subjected to different selection criteria, thus introducing selection bias. We did not have information on the exact payer mix within the inpatient group. As it is likely that the rate of commercially insured patients was higher at the HASC, this could be an additional source of selection bias. Moreover, while we utilized PSM to ensure baseline comparability between the groups, it is still possible that other unmeasured variables such as surgeon, socioeconomic status, and social support could have confounded the findings. Third, this study was conducted at a large private academic practice with 29 offices in the northeast region and an annual volume of approximately 17,000 joint replacements per year. As such, while a higher operational efficiency is one oft-cited advantage of ASCs compared to tertiary hospitals, it is possible that the similar evidence-based perioperative pathways implemented at the 2 surgical sites (ie, the HASC and tertiary hospital) could have led to the comparable surgical and OR times seen in this study. This finding may not be generalizable to other lower volume institutions. Fourth, we did not perform a comparison between the outcomes of TJA at an HASC and same-day discharge TJA; hence, the advantages of this new model of care over conventional outpatient TJA remain unknown, and further studies are needed to evaluate the cost-effectiveness of this new model of care. Nonetheless, the main purpose of this study was to compare the 90-day *safety* outcomes of outpatient TJA at HASCs with that of inpatient TJA at a tertiary hospital, given that no studies have described this before. In addition, we included patients who had surgery at 4 HASCs; hence, it is possible that some degree of heterogeneity could have been introduced. Furthermore, there are currently 10 of these ASCs that have been awarded the Advanced Certification for Total Hip and Knee Replacement from the Total Joint Commission [39]; hence, it remains uncertain whether the current findings can be generalized to other HASCs. An ongoing investigation of the safety and outcomes of this new model of care delivery should be conducted.

Conclusions

Patients who underwent outpatient TJA at a novel HASC had similar complication and readmission rates as those undergoing TJA at a tertiary hospital, but length of stay was lower. As the trend toward outpatient arthroplasty continues, it is imperative that the orthopaedic community continues to evaluate the safety and efficacy of HASCs to determine if this new model of care delivery should be further expanded.

Conflicts of interest

P. M. Courtney is a member of the speakers bureau of and does paid presentations for Smith & Nephew, is a paid consultant at DePuy, Hip Innovation Technology, Stryker and Zimmer, owns stock options at Parvizi Surgical Innovation, and is a board member of the AAHKS; C. A. Krueger is a paid consultant at Smith & Nephew, is a part of the editorial/governing board of the JOA, and is a board member of the AAOS and AAHKS; W. J. Hozack receives royalties from Stryker, is a paid consultant at Stryker and Valuhealth, owns stock options at Stryker, receives research support from Stryker, and is a part of the editorial/governing board of the JOA; all other authors declare no potential conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2019.12.004.

Informed patient consent

The author(s) confirm that informed consent has been obtained from the involved patient(s) or if appropriate from the parent, guardian, power of attorney of the involved patient(s); and, they have given approval for this information to be published in this article.

References

[1] DeMik DE, Carender CN, An Q, Callaghan JJ, Brown TS, Bedard NA. Has removal from the inpatient-only list increased complications after outpatient total knee arthroplasty? J Arthroplasty 2021;36:2297–2301.e1.

[2] Berger RA, Sanders SA, Thill ES, Sporer SM, Della Valle C. Newer anesthesia and rehabilitation protocols enable outpatient hip replacement in selected patients. Clin Orthop Relat Res 2009;467:1424–30.

[3] Hoffmann JD, Kusnezov NA, Dunn JC, Zarkadis NJ, Goodman GP, Berger RA. The shift to same-day outpatient joint arthroplasty: a systematic review. J Arthroplasty 2018;33:1265–74.

[4] Bert JM, Hooper J, Moen S. Outpatient total joint arthroplasty. Curr Rev Musculoskelet Med 2017;10:567–74.

[5] DeCook CA. Outpatient joint arthroplasty: transitioning to the ambulatory surgery center. J Arthroplasty 2019;34(7S):S48–50.

[6] Argenson J-NA, Husted H, Lombardi A, Booth RE, Thienpont E. Global forum: an international perspective on outpatient surgical procedures for adult hip and knee reconstruction. J Bone Joint Surg 2016;98:e55.

[7] Muve health bringing its new joint replacement model to the Philadelphia region. Philadelphia Business Journal. https://www.bizjournals.com/philadelphia/news/2019/08/01/muve-health-joint-replacement-surgery-philadelphia.html [accessed 24.04.21].

[8] Parcells Bertrand W, Dean G, David M, Smith A, Schottenfeld M, Harwood David A, et al. Total joint arthroplasty in a stand-alone ambulatory surgical center: short-term outcomes. Orthopedics 2016;39:223–8.

[9] Shah RR, Cipparrone NE, Gordon AC, Raab DJ, Bresch JR, Shah NA. Is it safe? Outpatient total joint arthroplasty with discharge to home at a freestanding ambulatory surgical center. Arthroplasty Today 2018;4:484–7.

[10] Klein GR, Posner JM, Levine HB, Hartzband MA. Same day total hip arthroplasty performed at an ambulatory surgical center: 90-day complication rate on 549 patients. J Arthroplasty 2017;32:1103–6.

[11] Toy PC, Fournier MN, Throckmorton TW, Mihalko WM. Low rates of adverse events following ambulatory outpatient total hip arthroplasty at a free-standing surgery center. J Arthroplasty 2018;33:46–50.

[12] Hoeffel DP, Daly PJ, Kelly BJ, Giveans MR. Outcomes of the first 1,000 total hip and total knee arthroplasties at a same-day surgery center using a rapid-recovery protocol. J Am Acad Orthop Surg Glob Res Rev 2019;3:e022.

[13] Carey K, Morgan JR, Lin M-Y, Kain MS, Creevy WR. Patient outcomes following total joint replacement surgery: a comparison of hospitals and ambulatory surgery centers. J Arthroplasty 2020;35:7–11.

[14] Mascioli AA, Shaw ML, Boykin S, Mahadevan P, Wilder JH, Bell JW, et al. Total knee arthroplasty in freestanding ambulatory surgery centers: 5-year retrospective chart review of 90-day postsurgical outcomes and health care resource utilization. J Am Acad Orthop Surg 2021;29:e1184–92.

[15] Phillips JLH, Rondon AJ, Vannello C, Fillingham YA, Austin MS, Courtney PM. A nurse navigator program is effective in reducing episode-of-care costs following primary hip and knee arthroplasty. J Arthroplasty 2019;34:1557–62.

[16] Austin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. Multivariate Behav Res 2011;46:399–424.

[17] Sershon RA, McDonald JF, Ho H, Goyal N, Hamilton WG. Outpatient total hip arthroplasty performed at an ambulatory surgery center vs hospital outpatient setting: complications, revisions, and readmissions. J Arthroplasty 2019;34:2861–5.

[18] Kolisek FR, McGrath MS, Jessup NM, Monesmith EA, Mont MA. Comparison of outpatient versus inpatient total knee arthroplasty. Clin Orthop Relat Res 2009;467:1438–42.

[19] Berger RA, Kusuma SK, Sanders SA, Thill ES, Sporer SM. The feasibility and perioperative complications of outpatient knee arthroplasty. Clin Orthop Relat Res 2009;467:1443–9.

[20] Goyal N, Chen AF, Padgett SE, Tan TL, Kheir MM, Hopper RH, et al. Otto aufranc award: a multicenter, randomized study of outpatient versus inpatient total hip arthroplasty. Clin Orthopaedics Relat Res 2017;475:364–72.

[21] Mai HT, Mukhdomi T, Croxford D, Apruzzese P, Kendall MC, De Oliveira GS. Safety and outcomes of outpatient compared to inpatient total knee arthroplasty: a national retrospective cohort study. Reg Anesth Pain Med 2021;46:13–7.

[22] Pollock M, Somerville L, Firth A, Lanting B. Outpatient total hip arthroplasty, total knee arthroplasty, and unicompartmental knee arthroplasty: a systematic review of the literature. JBJS Rev 2016;4:e4.

[23] Kimball CC, Nichols CI, Vose JG. Outpatient versus rapid recovery inpatient knee arthroplasty: comparison of matched cohorts. Orthopedics 2020;43:36–41.

[24] Darrith B, Frisch NB, Tetreault MW, Fice MP, Culvern CN, Della Valle CJ. Inpatient versus outpatient Arthroplasty: a single-surgeon, matched cohort analysis of 90-day complications. J Arthroplasty 2019;34:221–7.

[25] Yang J, Olsen AS, Serino J, Terhune EB, DeBenedetti A, Della Valle CJ. Similar 90-day outcomes among inpatient and outpatient arthroplasties: a single-surgeon matched cohort analysis. Bone Joint J 2021;103-B(7 Supple B):84–90.

[26] Courtney PM, Edmiston T, Batko B, Levine BR. Can bundled payments be successful in the medicaid population for primary joint arthroplasty? J Arthroplasty 2017;32:3263–7.

[27] Siddiqi A, White PB, Mistry JB, Gwam CU, Nace J, Mont MA, et al. Effect of bundled payments and health care reform as alternative payment models in total joint arthroplasty: a clinical review. J Arthroplasty 2017;32:2590–7.

[28] Advisory Board. Hospitals may lose total joint replacements to ambulatory providers. Daily Briefing. https://www.advisory.com/Daily-Briefing/2017/08/10/joint-replacement [accessed 02.07.21].

[29] Martín-Ferrero MÁ, Faour-Martín O, Simon-Perez C, Pérez-Herrero M, Pedro-Moro JAD. Ambulatory surgery in orthopedics: experience of over 10,000 patients. J Orthop Sci 2014;19:332–8.

[30] Kingery MT, Cuff GE, Hutzler LH, Popovic J, Davidovitch RI, Bosco JA. Total joint arthroplasty in ambulatory surgery centers: analysis of disqualifying conditions and the frequency at which they occur. J Arthroplasty 2018;33:6–9.

[31] O'Malley NT, Fleming FJ, Gunzler DD, Messing SP, Kates SL. Factors independently associated with complications and length of stay after hip arthroplasty. J Arthroplasty 2012;27:1832–7.

[32] Whippey A, Kostandoff G, Paul J, Ma J, Thabane L, Ma HK. Predictors of unanticipated admission following ambulatory surgery: a retrospective case-control study. Can J Anesth 2013;60:675–83.

[33] American Association of Hip and Knee Surgeons. Outpatient joint replacement: position of the American association of hip and knee surgeons. Outpatient joint replacement. https://www.aahks.org/position-statements/outpatient-joint-replacement/ [accessed 02.07.21].

[34] Moulton LS, Evans PA, Starks I, Smith T. Pre-operative education prior to elective hip arthroplasty surgery improves postoperative outcome. Int Orthop 2015;39:1483–6.

[35] Yoon RS, Nellans KW, Geller JA, Kim AD, Jacobs MR, Macaulay W. Patient education before hip or knee arthroplasty lowers length of stay. J Arthroplasty 2010;25:547–51.

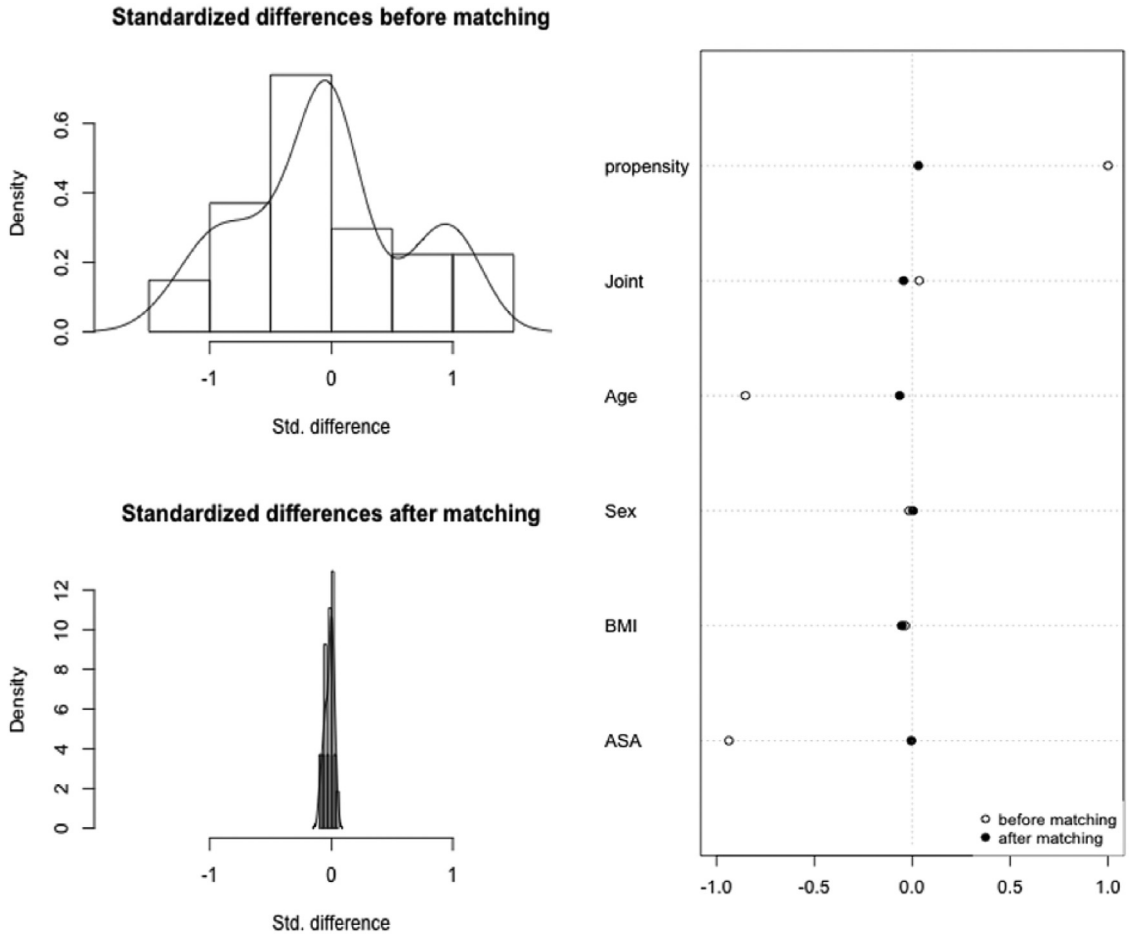
[36] Pelt CE, Gililland JM, Erickson JA, Trimble DE, Anderson MB, Peters CL. Improving value in total joint arthroplasty: a comprehensive patient education and management program decreases discharge to post-acute care facilities and post-operative complications. J Arthroplasty 2018;33:14–8.

[37] Ranawat AS, Ranawat CS. Pain management and accelerated rehabilitation for total hip and total knee arthroplasty. J Arthroplasty 2007;22:12–5.

[38] Guerra ML, Singh PJ, Taylor NF. Early mobilization of patients who have had a hip or knee joint replacement reduces length of stay in hospital: a systematic review. Clin Rehabil 2015;29:844–54.

[39] Advanced total hip and total knee replacement. The joint commission. https://www.jointcommission.org/accreditation-and-certification/certification/certifications-by-setting/hospital-certifications/orthopedic-certification/advanced-orthopedic/advanced-total-hip-and-total-knee-replacement [accessed 22.06.21].

Appendix



Supplementary Figure 1. Standardized mean differences (SMD) for each variable before and after propensity score matching (PSM).