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Original research

Outpatient total knee arthroplasty: is it economically feasible in the hospital setting?

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ABSTRACT

Background: With the removal of total knee arthroplasty (TKA) from the Medicare inpatient-only list, outpatient TKA can now be offered, irrespective of payer, in multiple sites. We compared time- and cost-effectiveness of outpatient TKA performed in a hospital outpatient department (HOPD) to that at an inpatient academic medical center (AMC).

Methods: We reviewed all outpatient TKAs performed at our AMC and our HOPD from August 2018 to July 2019. Time efficiency by phase of care was determined, and cost data were obtained from the hospital financial department. Patient selection for outpatient surgery was identical for each site of care.

Results: We identified 21 knees that had surgery at the HOPD and 65 knees that had surgery at the AMC. Demographics were similar in both groups. The AMC group had significantly longer in-facility to operating room (Δ (difference) = 33.5 minute, $P = .0003$), postanesthesia care unit to discharge ($\Delta = 158.8$ minute, $P < .0001$) and in-facility to discharge ($\Delta = 199.3$ minute, $P < .0001$) time periods compared to the HOPD group. The HOPD was significantly more cost-effective for the preoperative period ($\Delta = \$75.7$, $P < .0001$), postoperative period ($\Delta = \$315.1$, $P < .0001$), and total cost ($\Delta = \$241$, $P < .0001$).

Conclusions: Outpatient TKAs performed in an HOPD spend significantly less time within the facility than the ones performed in an AMC and cost significantly less. It is expected that approval of Medicare TKAs at ambulatory surgery centers will further improve cost and efficiency.

Introduction

As the US population ages, the demand for total joint arthroplasty (TJA) is expected to continue to increase. In 2016, the US Census Bureau estimated that the number of people in the United States aged 65 years and older was 49.2 million (15.2% of the population). By 2035, the bureau projects that, for the first time in US history, adults older than 65 years will outnumber children under 18 years. By 2060, the number of adults older than 65 years is projected to be 94.7 million (23.5% of the population) [1,2]. The estimated annual volume of primary total knee arthroplasty (TKA) procedures grew 148% between 2000 and 2014 to reach 680,150. Based on these data, Sloan et al. [3] showed that projected growth for TKA procedures will reach 935,000 annually by 2030. As the demand for services and cost grow, there is a greater need to increase health value by improving quality metrics and decreasing cost which has prompted the move toward lower cost sites of care and lower overall episode cost. In their study, Cutler and Ghosh [4] showed that osteoarthritis was the most expensive condition among Medicare patients aged 65 years and older.

As surgeons further seek to lower cost, attention has been turned to performing outpatient TJA in hospital outpatient departments (HOPDs) or ambulatory surgery centers (ASCs) as a potential source for further cost reduction. ASCs and HOPDs have important differences—HOPDs bill at a higher rate than ASCs because they are attached to hospitals and are subject to different regulatory environment, rather than an ASC, which is a free-standing center that need not be linked directly to an accredited inpatient hospital. ASCs may also be owned and managed by physicians, unlike HOPDs.

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The move to the outpatient setting has been largely facilitated by less invasive surgical techniques and improvements in pain management and adoption and improvement of enhanced recovery after surgery (ERAS) pathways [5-8]. Initially, there was concern that the cost of additional services required by patients who underwent outpatient TJA would outweigh benefits, but more recent studies have shown that outpatient TJA can be a successful and safe option in selected patients [9-13], with high patient satisfaction [14] and low complication rates [8].

Cost-effectiveness for outpatient total hip arthroplasty has been well-documented [15]. Literature about financial data comparing outpatient TKA between an academic medical center (AMC) and a HOPD is scarce. To the best of our knowledge, only one study has been published to date; it showed no difference in costs [16], however, only one TKA in each setting was compared.

The goals of our study were to calculate the time- and cost-effectiveness of outpatient TKA in an HOPD and in an AMC and to compare differences as well as to identify potential areas for improved efficiency.

We hypothesized that HOPDs were more time-effective and cost-effective than AMCs for outpatient TKA.

Materials and methods

Our study design was approved by our Institutional Review Board. Our practice began performing true outpatient TKA in December 2016 in our acute care hospital. Once the protocol had been formalized, we transitioned to performing these same procedures in our HOPD, which is geographically distinct from our AMC, approximately 2 miles away (our system does not have an ASC setting at present). We reviewed all outpatient TKA procedures over 1 year, from August 2018 to July 2019. The procedures were performed either at our AMC or at our HOPD.

Our outpatient criteria and protocol for patient selection for outpatient surgery were identical for each site of care (Table 1); site was determined based on patient scheduling preferences only. Four different time periods were compared: (1) preoperative time: in-facility to operating room (OR), (2) OR time: OR to postanesthesia care unit (PACU), (3) recovery time: PACU to discharge; and (4) total care episode time: in-facility to discharge. The time stamps were obtained through the standard electronic medical record (EPIC systems, Verona, WI). Cost data was obtained from the hospital financial department on a per-minute basis at both sites. Of note, this cost analysis represents data for labor and space activity costs only and does not include direct costs (eg, surgical implants, disposables) nor professional fees (which are the same for both sites based on contracting).

Statistical analysis: group analysis was conducted with unpaired *t*-test for parametric continuous data, Mann-Whitney test for nonparametric continuous data, and Fischer's exact test for categorical data. A *P*-value < .05 was deemed to be significant. With regard to the power analysis [17], the sample size was based on the precision of the main outcome we wanted to estimate, namely the difference in time and cost between the HOPD and the AMC. Because we found no previous data for our computation, we used a sample of 5 patients to estimate a mean difference of 30 minutes and a standard deviation of 11. Based on a normal distribution, including 40 patients would give us a precision at the 95% confidence interval (CI) of 5.3 (mean estimate: 30; 95% CI: 24.7-35.3). Similarly, we used the same sample of 5 patients to estimate a mean difference of $400 and a standard deviation of 44. Based on a normal distribution, including 40 patients would give us a precision at the 95% CI of 19.92 (mean estimate: 400; 95% CI: 380.08-419.92).

Table 1
Outpatient selection criteria.

Surgical factors	Medical factors	Social factors
Primary TKA 1st or 2nd case of the day[a]	Age <75 y BMI <35 kg/m^2 Absence of • Anemia, COPD, CHF • Cirrhosis • VTE history • Spinal stenosis • BPH • Chronic narcotics Surgeon discretion	RAPT ≥ 10 Proximity to hospital

[a] This rule applies to the academic medical center only; at the HOPD, all cases are eligible for home discharge.

Results

During the 1-year time period, we identified 21 knees (21 patients) that had surgery at the HOPD and 65 knees (63 patients) that had surgery at the AMC. Demographic analysis showed that HOPD and AMC patients were similar for age, body mass index (BMI), American Society of Anaesthesiologists (ASA) score, and gender (Table 2). HOPD patients were on average 63.7 years old with a BMI of 29.2 kg/m^2, and 57% female. AMC patients were on average 61.2 years old with a BMI of 30.4 kg/m^2, and 48% female.

Time analysis (Fig. 1) showed the AMC group had significantly longer preoperative time (in-facility to OR [Δ = 33.5 minute], $P = .0003$), recovery time (PACU to discharge [Δ = 158.8 minute], $P < .0001$), and total in-facility time ("admit" to discharge [Δ = 199.3 minute], $P < .0001$) compared to HOPD patients. Both groups had similar OR time (OR to PACU, 137.5 minute and 144.4 minute for HOPD and AMC, respectively), with the HOPD showing a nonsignificant time advantage, though with less variability. HOPD patients spent on average 6.5 hours (range, 5.4 to 7.6) in the facility whereas AMC patients spent 9.8 hours (range, 6.6 to 12.4), a 33.7% reduction of the total in-facility time spent at the HOPD compared to the AMC.

Cost analysis

Hospital-assigned costs per minute were $7.60 per minute of OR time in the HOPD and $6.20 in the AMC. Pre-op and PACU time were assigned a cost of $1.80 per minute at the HOPD and $1.90 per minute at the AMC. The HOPD was significantly more cost-effective for pre-op (Δ = $75.7, $P < .0001$), recovery (Δ = $315.1, $P < .0001$) and total care episode cost (Δ = $241, $P < .0001$) using the per-minute cost-assignment method (Fig. 2). Thus, cost savings at the HOPD represented 26%, 56.6%, and 14% for preoperative, recovery and total care episode time, respectively. The AMC was significantly lower cost for OR cost (Δ = $149.6, $P < .001$) in per-minute analysis.

Discussion

In a practice in which the same surgeons operate on similar patients in 2 different locations, it is important to understand whether there can be intrinsic differences in site of care that may influence the efficiency and value of care delivery. Husted et al. [16]

Table 2
Patient demographics.

Variables	HOPD (21)	AMC (63)	*P*
Age (years) ± SD	63.7 ± 10.2	61.2 ± 10.1	.34
BMI (kg/m^2) ± SD	29.2 ± 5.6	30.4 ± 5.6	.59
ASA score ± SD	2.5 ± 0.5	2.6 ± 0.5	.62
Gender	9M, 12 F	33M, 30F	.61

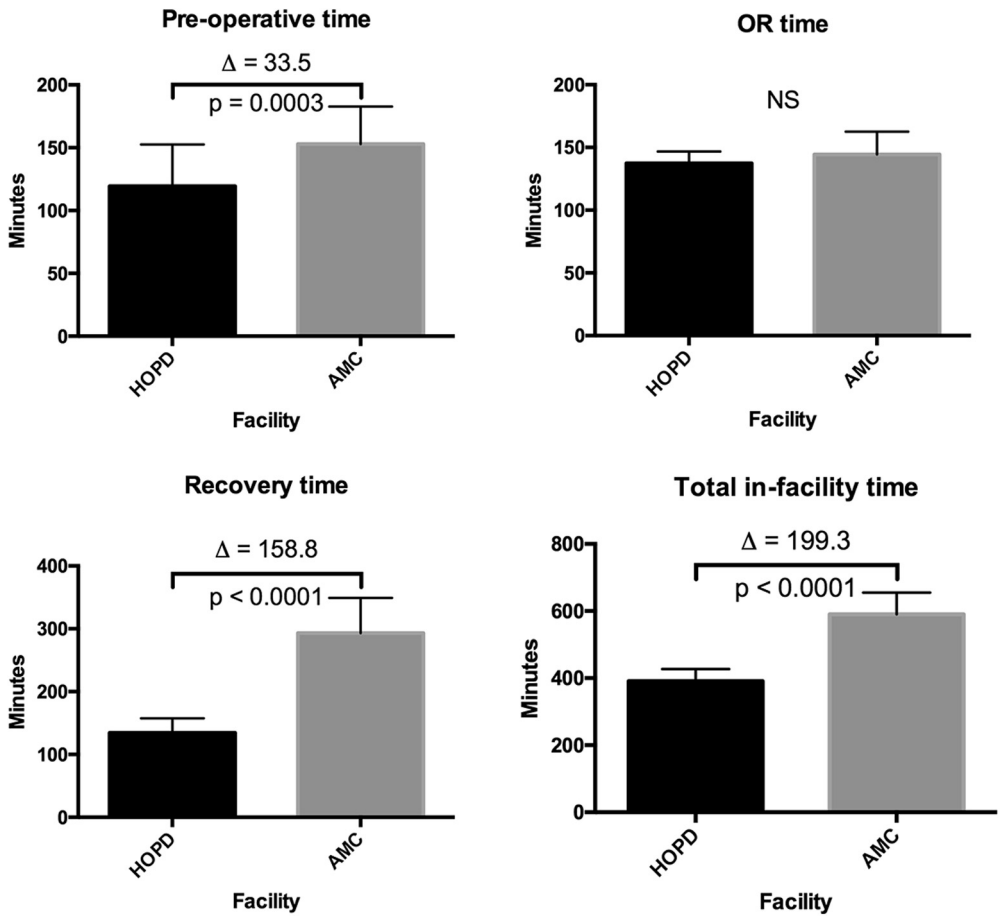

Figure 1. Time analysis comparing the 2 sites of care. The HOPD was more efficient in all phases of care except for the time in the actual operating room. NS, nonsignificant.

showed that outpatient center–based TJAs were more time efficient, by 29 minutes, compared to the hospital setting, but no statistical analysis was performed between the 2 groups. Our results showed that our HOPD was significantly more time-efficient than our academic tertiary care center except for the actual time spent in the OR. We believe this difference is most likely due to the fact that staff, nurses, and physical therapists are more prepared and organized for orthopaedic outpatient surgery and this cultural difference in an ambulatory-based site is in stark contrast to an inpatient environment in which the perioperative team is not fully aligned with outpatient pathways.

It is notable that the one area over which the surgeon has ownership showed no time differences, with intraoperative time being essentially equivalent. The surgeon, in our system, is the only member of the team incentivized toward time efficiency in both settings, which may explain why otherwise substantial time differences disappeared in the operating room itself. Our health system has made the management decision to also provide consistent team staffing in the TJA ORs in the AMC, which likely also contributes to this time equivalence. This commitment, however, to running a smaller total joint arthroplasty "unit within a unit" for preoperative and postoperative care has not been adopted, which may explain the time disparities between the 2 locations.

The differences in perioperative efficiency and incentivization likely explains our data, which shows that our HOPD was overall significantly more cost-effective than our AMC on a cost-per-minute basis. These results come in a context where national health care expenditures in the United States are projected to increase to nearly 20% of the gross domestic product by the year 2020 [18], and in which regulatory measures to control spending on TJA episodes are being rapidly implemented by the Centers for Medicare and Medicaid Services (CMS) [19]. In fact, the regulatory landscape for patients undergoing TKA is quickly changing: in 2018, TKA was removed from the CMS inpatient-only list and is expected to be approved for payment in the ASC setting as of January 2020. As Medicare remains the primary payer for TKA in the United States, this change has the potential to dramatically impact care delivery for knee arthritis patients. Surgeons will find it increasingly important to understand where they can best deliver high-efficiency, cost-favorable care. If the time and cost are substantially improved in the specialized outpatient setting, then multispecialty hospitals will have to compete to continue to perform these cases or concede them to smaller, more agile facilities.

Moreover, private payers are emphasizing lower cost sites of care as studies continue to demonstrate equivalent or improved outcomes in the outpatient setting at substantially lower cost to the health system [20,21].

Low-cost, high-value systems share several consistent characteristics, including a care team mutually aligned toward similar goals: providing high-quality care in a time-efficient manner, and sharing in financial and time rewards when care is cost-effective. Our outpatient surgical center rewards staff who work efficiently by allowing them to end their work day when they complete the day's scheduled work; in addition, teams are consistently assigned to similar cases and work flows, unlike an academic medical center where multispecialty care is the rule, and often rooms are run

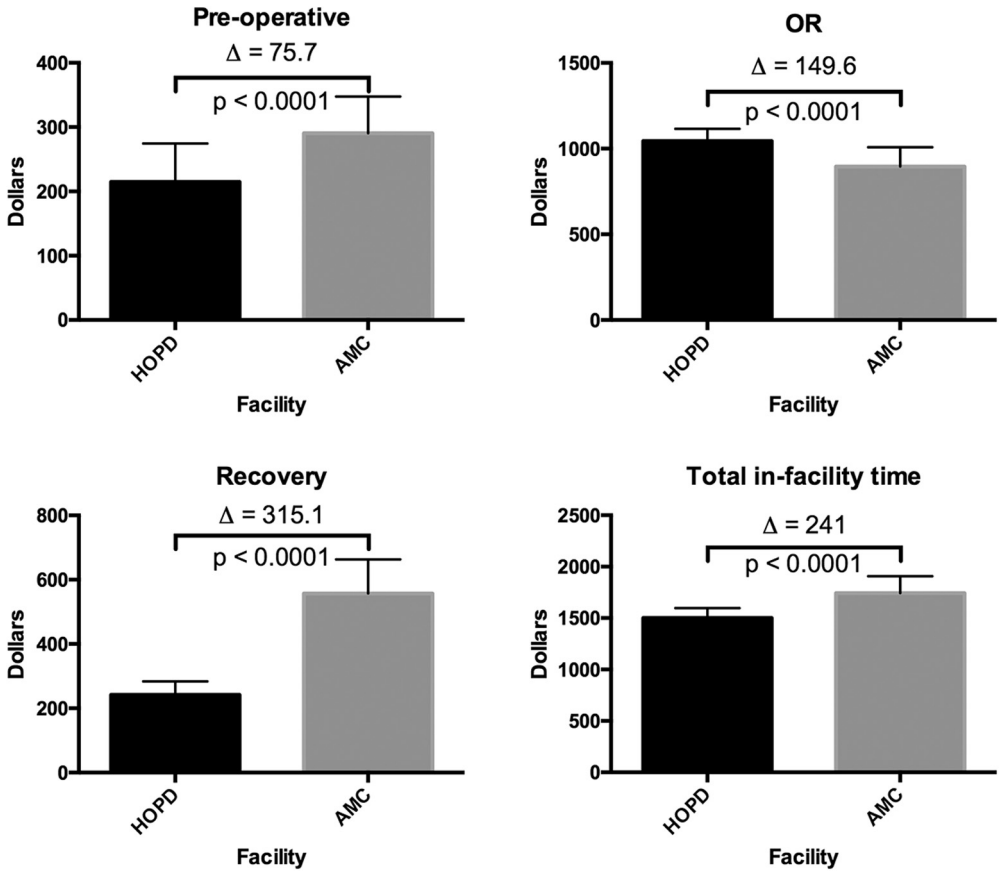

Figure 2. Cost analysis on a per-minute basis. This accounting method assigns costs using an average per-minute rate at a facility for all comers and does not include implants, disposables, and other direct costs.

explicitly with the intent to fill block time. Though these teams often have the breadth of knowledge to provide multispecialty tertiary care, they may lack the priority and incentives needed to achieve substantial time efficiency in highly specialized procedures like TKA.

Traditionally, cost has been determined by combining indirect costs (utilities, billing administration including salary, benefits, and contracts) and direct costs (OR resources, implants, disposables, radiology, nursing floor costs, including all salary, benefits, supplies, and contracts from these areas). Recently, time-driven, activity-based costing (TDABC) has been proposed as an additional and potentially more accurate determinate of the cost of a procedure [22,23]. However, TDABC studies involve a strong collaboration with the hospital financial service, which can be difficult to obtain, especially for understanding wage assignment in various locations.

The decision to use per-minute time in this study allowed an approximate estimate of the cost-benefit of time savings in our institution, though these data are missing many of the key cost generators for an arthroplasty episode, including disposables and implants. Variable direct costs are equivalent at both sites, however, due to supply chain and contracting equivalence. Other than time and personnel-related costs, the 2 sites are equivalent, with the same surgeons using the same disposables, implants, equipment, and surgical workflow regardless of location, with equivalent costing for these elements. The impact of these cost elements is thus expected to be minimal. Also, the staff at our HOPD are paid as salaried employees, which leads to a slightly inflated intra-op cost at that setting compared to the AMC. The authors acknowledge that a true TDABC study would be informative to further exploring these time and cost-efficiency differences.

This study has some limitations. First, its retrospective design could have led to inaccurate reporting and loss of data; to mitigate this potential issue, we used a computerized database, which captures all surgical cases, which helped us to gather accurate data. Second, our samples may be small, especially for our HOPD, but it represents the current activity at a large tertiary American academic medical center and is the largest such series of its kind, to our knowledge, comparing these 2 sites of care in these terms. Third, our cost assessment was limited to per-minute analysis, as stated previously. These data were derived based on institutional case rates that are maintained by our financial department, reflecting primarily personnel salaries at each site and an internal cost-assignment model for indirect costs which is kept confidential by hospital policy. This challenge reflects the opacity of traditional hospital accounting methods and reflects the importance of transparent data processes shared between physician teams and hospital administrators; a TDABC study comparing the 2 sites would help to further elucidate potential sources of efficiency improvement.

Conclusion

Our study showed that outpatient TKAs can be performed at an HOPD with significantly more time efficiency. In the operating room, where the surgeon leads the flow, both sites are equally efficient. If hospitals want cost-effective outpatient TKAs in a hospital environment, they will have to be able to optimize efficiency in the perioperative flow. It is expected that approval of Medicare TKAs at ambulatory surgery centers will further improve cost and efficiency through increasing competition.

Conflict of interest

Hari K. Parvataneni, MD, Board member for Arthroplasty Today; Medical/Orthopaedic publications editorial/governing board for AAOS, AAHKS, American College of Perioperative Medicine and Florida Orthopaedic Society. Hernan A. Prieto, MD, Medical/Orthopaedic publications editorial/governing board for Florida Orthopaedic Society - Chair Program Committee Member. Chancellor F. Gray, MD, Stock ROM3 Rehab systems; Board member for Florida Orthopaedic Society Program Committee.

All other authors declare no potential conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2020.02.004

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