Is Primary Total Joint Arthroplasty Becoming a Higher Value Procedure? *Trends in Inflation-Adjusted Time-Driven Activity-Based Costs and Patient-Level Value in 4,989 Procedures from 2016-2023*

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INTRODUCTION:
Primary total knee arthroplasty (TKA) and total hip arthroplasty (THA) have been transformed in the past decade. Outpatient surgery, preoperative optimization, and increased scrutiny on costs have revolutionized how surgeons delivery total joint arthroplasty (TJA) patient care. Previous studies have investigated temporal trends in TJA clinical outcomes or health care economics in isolation. However, to our best knowledge, no prior analysis on this topic has integrated clinical outcomes with costs together to investigate Health Care Value – defined as the ratio of patient-centered clinical outcomes to health care dollars spent. The primary aim of this study was therefore to determine whether primary TJA has become a higher Value procedure between 2016 and 2023.

METHODS:
We sourced 2,786 primary TKAs and 2,203 primary THAs from a prospectively-maintained multi-institutional database. Knee and hip osteoarthritis outcome score physical function-shortforms (KOOS-PS and HOOS-PS) were collected. In addition, 90-day revision rates and 1-year revision rates were recorded. Costs of care were determined using time-driven activity-based costing (TDABC), adjusted for inflation, and converted from US Dollars to cost units (CUs). Value was calculated as the quotient of 1-year change in KOOS-PS or HOOS-PS, and costs of care, and converted to a scale with a maximum of 100. Intuitively, these value variables - Value $_{KOOS-PS}$ for TKA and Value $_{HOOS-PS}$ for THA - represented the cost-effectiveness of patient-centered symptom improvement.

RESULTS:
From 2016 to 2023, an increasing proportion of patients had ASA scores of 3 or 4 in both TKA (2016: 20.0% to 2023: 44.4%; $p < 0.001$) and THA (2016: 10.4% to 2023: 34.5%; $p < 0.001$). There was limited variation by year in other baseline characteristics (**Table 1**).

Outpatient surgery rose dramatically in both TKA (2016: 0% to 2023: 74.9%; $p < 0.001$) and THA (2016: 0% to 2023: 80.7%; $p < 0.001$) (**Table 1**) Home discharges similarly rose in both TKA (2016: 80.0% to 2023: 96.8%; $p < 0.001$) and THA (2016: 86.1% to 2023: 93.1%; $p < 0.001$).

For TKA, mean 1-year improvement in KOOS-PS did not significantly change over the study period (2016: +15.8 to 2023: +14.7; $p = 0.088$) (**Table 2**). Similarly, for THA, mean 1-year improvement in HOOS-PS did not significantly change by year (2016: +24.1 to 2023: +25.1; $p = 0.981$). **Figure 1** depicts trends in KOOS-PS and HOOS-PS improvement over the study period.

In TKA, 90-day readmission rates fell over the study period (2016: 5.0% to 2023: 1.1%; $p < 0.001$). In THA, there was no variance in 90-day readmission rate by year ($p = 0.710$) (**Table 1**). Rate of revision within 1-year of surgery did not vary by year for TKA ($p = 0.105$) or THA ($p = 0.808$).

From 2016 to 2023, the overall Cost of Care fell dramatically for both TKA (2016: 1,463 CUs to 2023: 836 CUs; Percent Reduction: -42.9% $p < 0.001$) and THA (2016: 1,642 CUs to 2023: 1,013 CUs; Percent Reduction: -38.3%; $p < 0.001$) (**Table 2**). **Figure 2** and **Figure 3** depict the reduction in costs of care over time for TKA and THA, respectively. The largest contributor to cost of care reductions were decreasing Personnel Costs for both TKA (2016: 721 CUs to 2023: 306 CUs; Percent Reduction: -57.6%; $p < 0.001$) and THA (2016: 752 CUs to 2023: 365 CUs; Percent Reduction: -51.5%; $p < 0.001$) (**Table 2**).

As a result of steady or improving outcomes but streamlined costs, the 1-year value quotients – Value $_{KOOS-PS}$ and Value $_{HOOS-PS}$ – rose for both TKA (2016: 10.9 to 2023: 17.7; $p < 0.001$) and THA (2016: 14.6 to 2023: 24.8; $p < 0.001$).

DISCUSSION AND CONCLUSION:
Primary TJA has become a higher value procedure over the past decade. Outpatient surgery, shorter lengths of stay, and a higher proportion of home discharges have streamlined costs, while maintaining or improving PROMs, readmission rates, and revision rates. The costs to the health care system of delivering a high-quality TKA and THA in 2023 are 42.9%

and 38.3% lower, respectively, than in 2016. When contextualized with other literature, our findings suggest that primary TJA is becoming a more cost-effective procedure over the past decade, but hospitals are financially benefiting more than patients and surgeons. These findings can inform ongoing efforts to adjust payment and reimbursement rates for TJA, with the aim of aligning incentives between patients, surgeons, and hospitals. Such efforts can ensure the long-term financial sustainability of high-quality patient-centered TJA health care delivery.

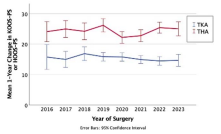

Figure 1. Trends in 1-year improvement in KOOS-PS and HOOS-PS for primary TKA and THA patients, respectively, from 2016 to 2023.

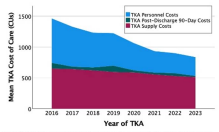

Figure 2. Trends in costs of care for primary total knee arthroplasty (TKA) by year of surgery from 2016 to 2023. Costs are adjusted for inflation and converted from US Dollars to arbitrary Cost Units (CUs) to preserve the confidentiality of hospital proprietary financial information.

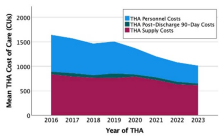

Figure 3. Trends in costs of care for primary total hip arthroplasty (THA) by year of surgery from 2016 to 2023. Costs are adjusted for inflation and converted from US Dollars to arbitrary Cost Units (CUs) to preserve the confidentiality of hospital proprietary financial information.