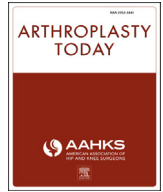




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## Original research

## Variation in the cost of care for primary total knee arthroplasties

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## ABSTRACT

**Background:** The study examined the cost variation across 29 high-volume US hospitals and their affiliated orthopaedic surgeons for delivering a primary total knee arthroplasty without major complicating conditions. The hospitals had similar patient demographics, and more than 80% of them had statistically-similar Medicare risk-adjusted readmission and complication rates.

**Methods:** Hospital and physician personnel costs were calculated using time-driven activity-based costing. Consumable supply costs, such as the prosthetic implant, were calculated using purchase prices, and postacute care costs were measured using either internal costs or external claims as reported by each hospital.

**Results:** Despite having similar patient demographics and readmission and complication rates, the average cost of care for total knee arthroplasty across the hospitals varied by a factor of about 2 to 1. Even after adjusting for differences in internal labor cost rates, the hospital at the 90th percentile of cost spent about twice as much as the one at the 10th percentile of cost.

**Conclusions:** The large variation in costs among sites suggests major and multiple opportunities to transfer knowledge about process and productivity improvements that lower costs while simultaneously maintaining or improving outcomes.

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## Introduction

Health care providers are coming under greater financial pressure, especially from more value-based and accountable payment methods. To cope, they need to understand their costs accurately over the full course of treatment by medical condition. Previous efforts to understand cost variation across providers have used measurement approaches that did not reflect the actual cost of the people and equipment used to deliver care. For example, studies of abdominal and congenital heart surgery [1,2] used the ratio of cost-to-charges (RCC) method, a widely-used but inaccurate health care costing method. The RCC method assumes that the cost to perform each service is the same percentage of the charge for each service.

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For instance, if total costs in a unit are \$1.2 million and total charges are \$2 million, the RCC method estimates the cost to perform each service as 60% of the service's charge. While the RCC approach is simple to understand and easy to implement, it is inaccurate because the charges have not been established based on actual costs of resources used to deliver each service.

We applied time-driven activity-based costing (TDABC) to study the cost variation for performing total joint arthroplasties (TJAs) at 29 high-volume hospitals. TDABC, a bottoms-up approach, uses process mapping to identify the types and costs of all personnel utilized in each step of a complete cycle of care [3-6]. TDABC has previously been used to examine the costs of TJAs at individual sites [7,8].

TJAs are one of the most commonly performed major surgeries in the country. Currently, more than 1 M joint arthroplasties are performed per year in the United States, and the number is projected to reach 4.05 M per year by 2030 [9,10]. Also, motivating this study is the increased use of bundled payments for joint arthroplasties, which causes hospitals to become more financially accountable for their costs of care. The Centers for Medicare and Medicaid Services introduced bundled payments in 2013 through a Bundled Payments for Care Improvement initiative, comprised of 4 models of bundled payments across a range of medical and surgical

conditions, including TJAs. In April 2016, Centers for Medicare and Medicaid Services introduced the Comprehensive Care for Joint Replacements model for primary TJAs. This payment initiative holds hospitals financially accountable for all related Medicare Part A and B expenditures from the time of hospital admission through 90 days post discharge [11]. Beyond these public payer programs, a national alliance of leading providers has been established to offer orthopaedic surgeries at a fixed bundled price directly to large employers and employer groups [12].

The present study brought together 29 US-based sites to facilitate the measurement of their direct costs of providing a total knee arthroplasty (TKA) and help them to understand the primary drivers of cost variation across providers. Overall, Medicare data indicate that 95%-97% of hospitals were not statistically different from one another on risk-adjusted complication and readmission rates for TKAs (Table 1) [13]. While these quality measures are not comprehensive, the little variation among them indicates large opportunities to reduce the variation in costs of TKAs without adversely impacting outcomes. Previous research has documented wide variation in reimbursement rates and hospital and physician charges [14,15]. A recent study showed a 380% variation in reimbursement rates across the country for TKAs, including as much as a 2.67× difference within a single geographic market [16]. These studies, however, have not compared providers' actual costs for delivering TKAs over an entire cycle of care.

## Material and methods

The article authors and the Institute of Healthcare Improvement organized a Joint Replacement Learning Community during calendar year 2014 to measure the value and improve the performance of the participating hospitals ("sites"). Hospitals that performed at least 200 primary TJAs in the prior year were eligible to participate. Thirty-two hospitals enrolled in the program, 29 were from the United States. The participating hospitals performed an average of 800 TJAs in 2013.

Nine of the US-based hospitals were academic medical centers; 20 were community hospitals. Their TJA patients had similar average age (65 years) and body mass index of 31 [17]. We excluded cases with major complicating conditions by studying only cases equivalent to a Medicare Severity-Diagnosis Related Group (MS-DRG) of 470. Twenty-four of the providers had risk-adjusted readmission and complications rates for TJAs that were no different than average based on Medicare Hospital Compare data. Two organizations had rates that were statistically better than average, and 3 organizations were worse on one or both outcome dimensions [13].

The analysis included costs over a care cycle that started with the initial office visit at which the decision for surgery was made and concluded 90 days post discharge. It included the costs of care delivered by physicians, whether employed at the hospital or not, and for postacute care, such as for rehabilitation and therapy.

**Table 1**  
Medicare risk-adjusted complication and readmission rates [10].

Comparison	Risk-adjusted complication rate (%)	Risk-adjusted readmission rate (%)
Better than US national rate	3	2
No different than US national rate	95	97
Worse than US national rate	2	1

Source/notes: Hospital Compare data. 2015 [cited 2015 April 12]. Available from: <https://data.medicare.gov/>

Except for the postacute care costs, the analysis focused on direct personnel and consumable supply costs. We excluded space and equipment costs since our previous research projects found these costs to be less than 10% of personnel and supply costs [18]. We also excluded indirect costs, such as information technology, human resources, and billing, as assigning these costs accurately would have required extensive cost modeling and analysis for every indirect and overhead cost category in the hospital.

We used TDABC to measure the direct personnel costs and trained the sites on the approach [4–6]. TDABC involves identifying the clinical and administrative activities performed over the care cycle, including the types of clinicians and staff members that perform each activity and the amount of time each personnel type spends on each activity. The second step in the TDABC process calculates the cost per minute for each of the personnel types used in the care cycle. The cost per minute divides the fully loaded cost for each type of personnel (compensation plus benefits) by the quantity of time that each personnel type has available for performing productive work per year on average. The employee activity time is then multiplied by the employee's cost per minute and summed across all employees to calculate total personnel costs. For example, if a nurse spends 20 minutes with a patient during an office visit (inclusive of prep and follow-up time), and the fully loaded cost for that nurse is \$1.50/minute, then the cost of nursing time for the visit is \$30. The cost of all of the resources utilized as part of a particular service (eg, a clinic visit, a rehabilitation session, or a surgical intervention) can then be summed together to determine the total cost of that service [3].

The organizations used actual purchase prices, the price the organization paid to the manufacturer or distributor, as the cost for consumable supplies. For postacute care costs, the organizations used internal cost estimates when they provided the service and external claims data when internal cost data were not available.

The unit of analysis for the study was the average cost to deliver the care for primary TKAs at each site. The project teams reported their cost data in a common format with a web-based system, developed by the study authors, which then calculated the TDABC costs for each site. The authors analyzed the consolidated data to compare costs across sites for the complete care cycle, as well as for important segments within the care cycle, such as preoperative, day of surgery, postacute care, and for different categories of expense, principally personnel and purchased supplies. A unique capability of the TDABC costing approach enabled the authors to use accounting variance analysis to adjust for differences in labor cost rates across the sites [19]. The authors could also identify the variation in postacute care spending caused by differences in payments for different types of postacute care services (eg, home health care vs skilled nursing facility) across sites.

The sites had the option to either report costs for the site on average or to provide a breakdown of costs based on the practices of individual physicians. In the latter situation, we used an average cost across physicians for those sites.

The authors performed a separate analysis of the costs of the prosthetic implant, the largest single cost component for TKAs [20]. The sites replied to a survey asking them to report the average purchase price for prosthetic implants used in primary TKA procedures for DRG 470 over the 12 months ending September 30, 2013. They reported their average purchase price with in \$500 ranges. For statistical analysis, we used the midpoint of each price point range [21].

## Results

Table 2 summarizes the variation in costs across the 29 sites. Due to nondisclosure agreements with the participating hospitals, we show the cost comparisons in indexed form, rather than the actual

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