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A 90-Day Episode-of-Care Cost Analysis of Robotic-Arm Assisted Total Knee Arthroplasty

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Introduction

Although a number of non-surgical and surgical management modalities exist, total knee arthroplasty (TKA) has been considered the gold standard procedure for end-stage knee OA[1]. For most patients, this surgery is highly successful, resulting in substantial improvements in quality of life and function[2]. However, despite the number of clinical and economic benefits of TKA, due to the high demand and volume of this procedure, the associated overall healthcare costs present substantial financial burden on payers. One way to potentially help contain healthcare costs is the utilization of technological advances, such as robotic-assistive technology, in the operating room[3]. Therefore, the purpose of this study was to perform a cost analysis between robotic-arm assisted TKA and manual TKA (mTKA) techniques. Specifically, we compared: 1) 90-day EOC costs, as well as several variables within the episode, including 2) index costs; 3) index lengths-of-stay (LOS); 4) discharge disposition; and 5) readmission rates.

Methods

A retrospective claims analysis was performed to provide longitudinal assessments of Medicare FFS beneficiaries who underwent rTKA and mTKA procedures performed between January 1, 2016 and March 31, 2017 (referred to as the index period), and included the following services: Inpatient, Outpatient, Skilled Nursing (SNF), and Home Health Agency (HHA). Patients were matched rTKA to mTKA in a 1-to-5 ratio. Patients were matched based on the following criteria: age, sex, race (as defined by

CMS), geographic division (based on U.S. Census Bureau divisions), and high-cost comorbidities [including Chronic Obstructive Pulmonary Disease (COPD), Hypertension, Diabetes, Coronary Artery Disease (CAD), Smoking, Pneumonia, Cancer, and Obesity]. After PSM, 519 rTKA and 2,595 mTKA were identified and included for analysis. The overall 90-day EOC costs, including the index procedures, LOS, discharge dispositions, and readmissions were calculated. A Generalized Linear Model (GLM) was selected to test for statistical significance due to the data not being normally distributed. Statistical comparisons were made of EOC costs in the 90-day post-index period. A two-part model was created to conduct statistical analyses of the probability of having utilization as well as the associated costs in each post-operative cost setting. A binomial regression with log link was used to test the probability of having costs or utilization in the 90-day post-index period in the first part of the model.

Results

Overall 90-day EOC costs for rTKA patients were found to be significantly less than that for mTKA patients ($18,568 vs. $20,960). These amounts showed that rTKA patients have an 11% ($2,391) lower average cost associated with their post-operative 90-day window of care (p<0.0001).

Overall index facility costs to the payer for rTKA patients were found to be significantly less than that for mTKA patients ($12,384 vs. $13,024; p=0.0001). These amounts for rTKA patients demonstrates a 5% ($640) lower cost associated with their index facility costs.

Over 90% of patients in both cohorts utilized post-acute services, with rTKA accruing $1,744 (25%) less costs than mTKA (5,234 vs. $6,978; p=<0.0001). Post-acute savings can be potentially attributed to rTKA patients being discharged to home with care (57 vs. 47%; p<0.0001) or self-care (28 vs. 24%; p=0.0566) more frequently, and SNF less frequently (12.52 vs. 21.70%; p<0.0001).

In addition to discharge disposition, while over 90% of members in both cohorts utilized post-acute services, rTKA members utilized fewer post-acute services(91% vs. 94%; p=0.0654). Differences in utilization were most notable in the SNF and ER settings. Robotic TKA members were 47% less likely to have a SNF admission, and 16% less likely to utilize ER services in the 90-day post-index period (14% vs. 26%; p<0.0001 and 11 % vs. 13%; p=0.1726,).

Among those members utilizing post-acute services, rTKA members experienced decreased post-index LOS and fewer visits. Most notably, rTKA members utilized fewer days in inpatient (4 vs. 7; p<0.0001) and SNF care (15 vs. 16; p=0.0642). Aside from inpatient services, rTKA members also utilized fewer outpatient and HHA visits, with rTKA members having 17% fewer outpatient visits (3.00 vs. 3.59; p=0.0004), 13% fewer ER visits (1.09 vs. 1.25; p=0.3545) and 16% fewer HHA visits compared to mTKA (11.94 vs. 14.28; p<0.0001).

The aforementioned reductions in healthcare utilization resulted in decreased costs for the rTKA cohort. Members in the rTKA cohort averaged $1,744 (25%) fewer costs overall than those in the mTKA cohort ($5,234 vs. $6,978; p=0.0001). In addition to significant savings in the outpatient ($699 vs. $839; p=0.0019), SNF ($7,201 vs. $7,947; p=0.0230), and HHA settings ($3,045 vs. $3,536; p<0.0001), savings were also realized in the inpatient and ER settings. rTKA members were also less likely to have costs for SNF admissions and ER visits as compared to mTKA (13.49% vs. 25.55%; p<0.0001 and 11.18% vs. 13.26%; p=0.1802, respectively).

rTKA patients had a 90-day readmission reduction of 33% (p=0.0423), when compared to m TKA patients.

Discussion
The results from this study show rTKA to be associated with significantly lower 90-day EOC costs. These lower rTKA patient costs are likely attributable to the significantly lower index costs, increased likelihood of being discharged to home, shorter LOS, and decreased readmission rates, when compared to mTKA patient costs. Additional contributing factors may include a number of RAA-associated clinical, radiographic, and patient outcome advantages [4–10]. Future studies should build on these findings, by performing hospital and surgeon-specific cost analyses. Additionally, these data entertain further discussions regarding health-care cost-containment with operating-room technology utilization. Based on this data, robotic-arm assisted surgery appears to be cost-effective and provide added value for patients undergoing total knee arthroplasty. As a result of these findings, robotic-arm assisted surgery can be an effective tool in managing existing value based care programs while also delivering value given its ability to promote efficiencies through the EOC journey.

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