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Mortality, Cost, and Health Outcomes of Total Knee Arthroplasty in Medicare Patients

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ABSTRACT

There are little data that quantify the long term costs, mortality, and downstream disease after Total Knee Arthroplasty (TKA). The purpose of this study is to compare differences in cost and health outcomes between Medicare patients with OA who undergo TKA and those who avoid the procedure. The Medicare 5% sample was used to identify patients diagnosed with OA during 1997–2009. All OA patients were separated into non-arthroplasty and arthroplasty groups. Differences in costs, mortality, and new disease diagnoses were adjusted using logistic regression for age, sex, race, buy-in status, region, and Charlson score. The 7-year cumulative average Medicare payments for all treatments were \$63,940 for the non-TKA group and \$83,783 for the TKA group. The risk adjusted mortality hazard ratio (HR) of the TKA group ranged from 0.48 to 0.54 through seven years (all $P < 0.001$). The risk of heart failure in the TKA group was 40.9% at 7 years (HR = 0.93, $P < 0.001$). The results demonstrate the patients in the TKA cohort as having a lower probability of heart failure and mortality, at a total incremental cost of \$19,843.

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Knee osteoarthritis (OA) is common condition afflicting 12.1% or 27 million people of the US population [1]. Total knee arthroplasty (TKA) is a cost effective procedure that alleviates pain and imparts functional improvement to the patients with arthritis [2]. There is a rapid and substantial improvement in pain, function, and quality of life in 90% of patients, while 85% of patients are satisfied with the surgery [3]. In direct comparison, TKA has been shown to provide improvement in multiple functioning scales while non-treatment patients have declined according to the same measures [4]. Despite the success of TKA, patients who are candidates may defer or avoid surgery due to a number of reasons. Surgery is indicated for patients with end-stage disease when all non-operative measures have failed to control pain [5]. It is believed that refusing or delaying TKA for patients with end-stage disease may lead to joint instability, worsening deformity, joint contractures, muscle atrophy, and an inability to perform activities of daily living [4,5].

While the short term benefits of surgery are well known, there are little long-term data that quantify the cost, mortality, and burden of downstream disease after knee arthroplasty. It is hypothesized that pain relief and restored function can have a positive effect on a patient's overall health. Patients experiencing less pain are likely to be

more active, thus potentially reducing the risk of cardiovascular and other diseases [6–8]. It has been suggested that improved mobility and function, along with reduced pain, may also lead to a reduced mortality risk in the long term [9]. Several studies have shown arthroplasty patients to have a reduced mortality risk compared to the general population, although the exact reasons remain unclear [10–15].

The purpose of the present study was to determine the differences in cost and health outcomes, including mortality, between patients with knee OA who underwent TKA versus patients with Knee OA who did not receive TKA. The hypothesis of the study was that patients receiving TKA have a lower adjusted risk of downstream diabetes, cardiovascular diseases, depression, and mortality.

Materials and Methods

The Medicare 5% Limited Data Set (LDS) sample was used to identify patients with OA of the knee during the period of 1997 to 2009. Knee osteoarthritis patients were identified using ICD-9 codes within the 715.X6 family. The OA code was required to be the principal diagnosis and occur more than once during a 12-month period to be included in the study. Patients were recruited continuously during the study period and followed until the end of the study period (December 31, 2009), until their benefits were terminated, or until death. Patients who received benefits for a reason other than age (i.e., end-stage renal disease or disability) or Medicare beneficiaries who received their care through the Medicare

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Advantage (Part C) program were excluded. Patients' enrollment status, age, and date of death were tracked using the matching 1997–2009 Medicare denominator files. OA patients were separated into arthroplasty and non-arthroplasty groups using the presence of ICD-9 code 81.54 for the knee arthroplasty group. The arthroplasty group was allowed to have received their TKA at any point after their OA diagnosis. The arthroplasty procedure was confirmed by the appropriate CPT4 code (27447) in the Part B (Physician Services) portion of the database. To normalize the comparison, only newly diagnosed patients were considered in the analysis. To ensure this, included patients must have had an entire year without a knee OA diagnosis prior to the index OA diagnosis.

Outcomes of interest included average annual payments (payer cost) adjusted to Jan-2011 U.S. Dollars, mortality, and diagnoses of heart failure (ICD-9 428), diabetes (ICD-9 250), and depression (ICD-9 309 and 311). Heart failure was chosen as a downstream effect of cardiovascular disease given its serious nature and the fact that it is potentially modifiable by the intervention (TKA), which may lead to increased activity and decreased risk of developing cardiovascular disease. Average medical costs were quantified over each period for patients who were fully observable for the entire period (i.e. they had the full period of follow-up and did not die or withdraw from Medicare). Differences in risk ratios between arthroplasty and non-arthroplasty groups for each outcome were adjusted using logistic regression, controlling for age, sex, region of residence, comorbidities (Charlson comorbidity index), socioeconomic status (using the Medicare buy-in status as surrogate), and previous disease diagnoses. The Charlson index quantifies the presence of comorbid conditions into a single score, and has been determined to be a valid method for estimating the risk of death from comorbid disease [16]. A generalized linear model comparing costs for each group adjusted for the same factors. Year of diagnosis was treated as a covariate in the analyses, testing whether the treatment effects and costs were changing over time.

Medicare costs, mortality, and disease diagnoses were obtained at one, three, five, and seven years after OA diagnosis and compared for the both groups. Two cost amounts were considered; all costs (for any diagnosis) and only those that included arthritis-attributable (with OA as the principal diagnosis) direct health care costs covered under Medicare parts A and B, including those for Inpatient, Skilled Nursing, Hospice, Outpatient, Physician Services, Home Health Agency Services, and Durable Medical Equipment.

Results

Results are presented for patients who had available 1, 3, 5, and 7 years of follow-up data. The study included 134,458 patients with at least one year of follow-up of whom 53,829 received TKA and the remaining 80,629 patients did not have TKA. The number of patients with 7-year follow up was 39,183 in the non-TKA and 25,904 in the TKA group. The demographic characteristics for both groups are shown in Fig. 1. Fig. 2 shows survival analysis curves for time between diagnosis of OA and surgery. Considering all patients in the study over all years, the curves indicate that 31% of OA patients receive a TKA within the first 24 months after OA diagnosis. The rate at which patients receive a TKA tapers slightly with 50% of patients having undergone TKA at 112 months after diagnosis of OA. Based on the examination of survival curves, it appears that patients are receiving a TKA earlier after the OA diagnosis in the latter years of the study.

Fig. 3 shows the cumulative medical costs for both TKA and non-TKA groups. At 1-year, the average payment was \$11,890 for the non-TKA group and \$24,123 for the TKA group, an incremental cost of \$12,233. The 7-year cumulative average Medicare payments for all treatments for all medical care were \$63,940 for the non-TKA group and \$83,783 for the TKA group, an incremental seven-year cost of \$19,843.

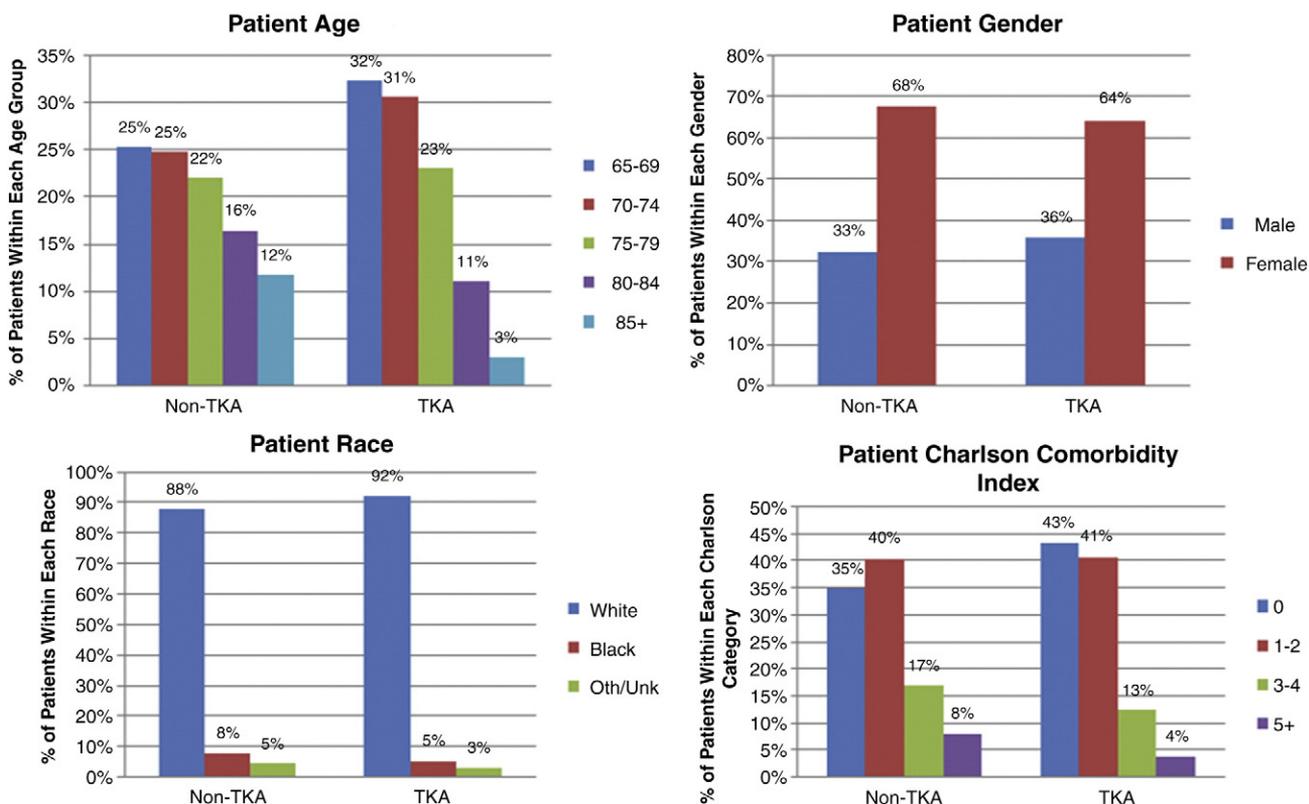


Fig. 1. Distribution of patient age, gender, race and Charlson Index for the TKA and non-TKA groups.

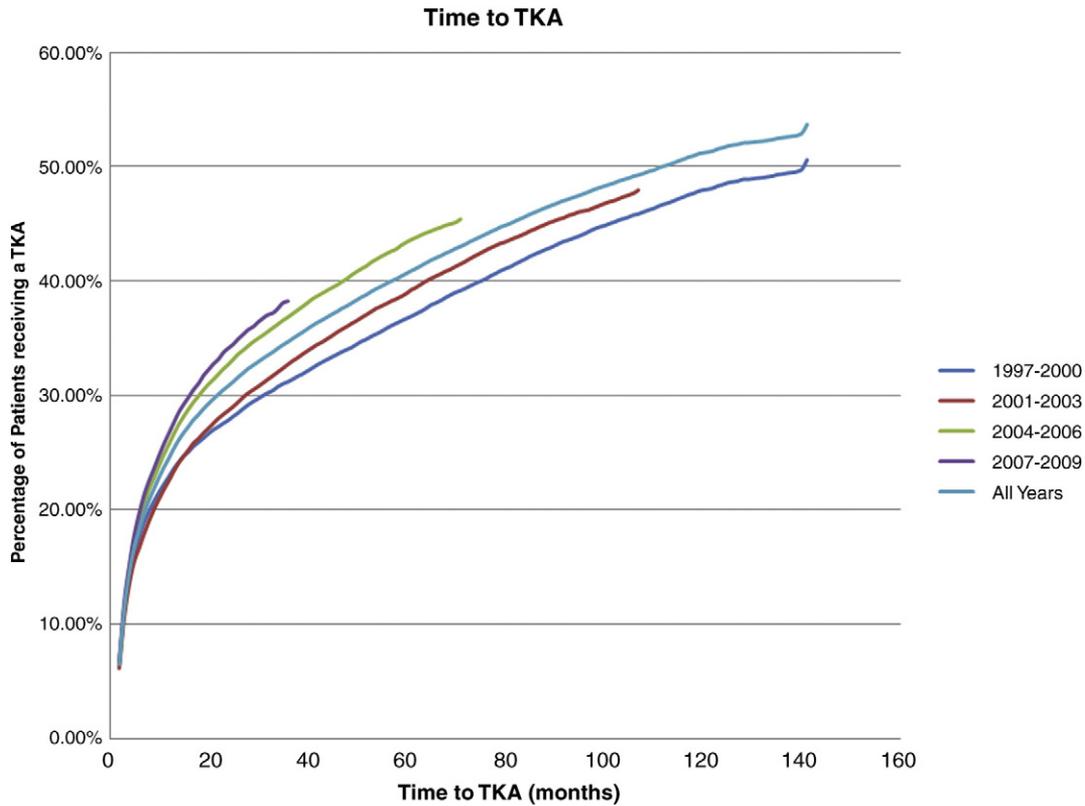


Fig. 2. Survival analysis curves for time between OA diagnosis and surgery. The curves represent the percentage of patients with OA who receive a TKA at a particular time point.

Table 1 shows the mortality ratios for Heart Failure, Diabetes, Depression, and Mortality. (Hazard ratios can be used to determine disease risks for the arthroplasty group by scaling those reported for

the non-arthroplasty group.) The mortality hazard ratio (adjusted) of the TKA group ranged from 0.48 to 0.54 through seven years (all $P < 0.001$). The incidence of heart failure for the TKA group was 21.1%

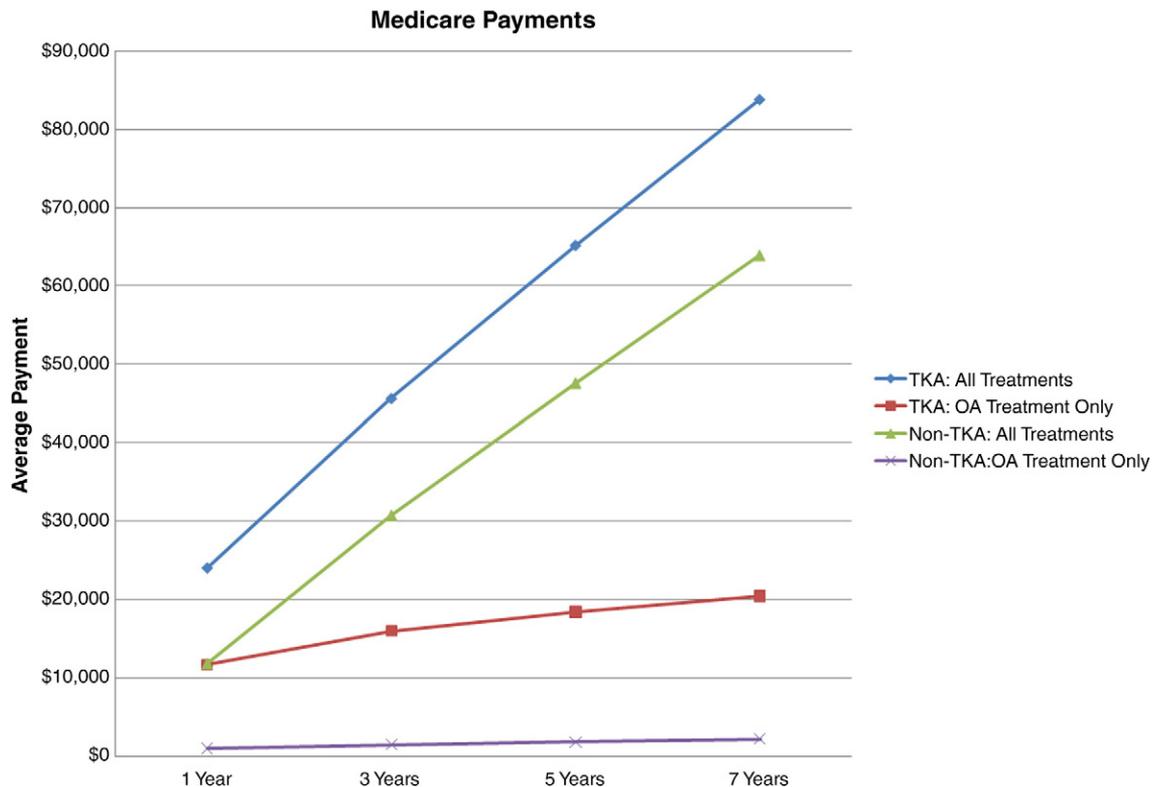


Fig. 3. Cumulative medical costs for both TKA and non-TKA groups. Costs are categorized for "All Treatments", which include all Medicare payments, and for "OA Treatment Only", which only includes costs for which osteoarthritis is the principal diagnosis.

Table 1
Hazard Ratios for Mortality and New Disease Diagnoses After OA.

	Years After Surgery											
	1 Year			3 Years			5 Years			7 Years		
	Rate (%)	Hazard Ratio	P	Rate (%)	Hazard Ratio	P	Rate (%)	Hazard Ratio	P	Rate (%)	Hazard Ratio	P
Heart Failure	15.0	1.00	0.9155	29.7	0.89	<.0001	41.2	0.91	<.0001	51.6	0.93	<.0001
Diabetes	27.5	1.05	0.0153	37.2	0.98	0.1636	43.3	1.00	0.9399	47.1	1.05	0.0117
Depression	9.1	1.28	<.0001	18.7	1.05	0.0093	26.1	1.00	0.7708	31.7	1.03	0.151
Mortality	3.1	0.49	<.0001	12.2	0.48	<.0001	22.9	0.50	<.0001	34.4	0.54	<.0001

The rate for each diagnosis is reported for the non-TKA group, while the hazard ratio estimates the relative risk for the TKA group compared to the non-TKA group.

at 3 years (HR=0.89, $P<0.001$) and 40.9% at 7 years (HR=0.93, $P<0.001$). The risk of depression was higher for the TKA group at 1 year (rate=9.37%, HR=1.28, $P<0.0001$) and 3 years (rate=17.1%, HR=1.05, $P<0.0093$), but there were no significant differences at 5 and 7 years. There was a slightly higher risk for diabetes in the TKA group at 1 year (rate=24.8%, HR=1.05, $P=0.0153$) and 7 years (rate=45.5%, HR=1.05, $P=0.0117$), but not at 3 and 5 years.

Discussion

This study, the first of its kind as far as we are aware, evaluates cost and disease burden for Medicare patients with osteoarthritis (OA) of the knee. The analysis of the 5% Medicare sample demonstrated that patients with OA of the knee who underwent TKA had a mortality risk that was approximately half that of the non-TKA group. There was also a reduction of new diagnoses of heart failure at 3, 5, and 7 years after surgery. The study was a broad population-based observational analysis across a patient cohort that constitutes a significant burden of osteoarthritis on the U.S. healthcare system. The incremental seven-year cost of TKA was found to be \$19,843 per patient.

A number of studies have examined the mortality risk of arthroplasty either in the short term (up to 90 days after surgery) or compared to the general population in the long term. Most of these studies have focused on hip arthroplasty. Lie et al. [17] found that patients from the Norwegian national registry undergoing a THA had a reduced mortality risk (HR=0.81) compared to the general population at eight years after surgery, despite having a greater 60-day risk of mortality (HR=1.39). Garellick studied 372 Swedish patients with THA and found the mortality to decrease in osteoarthritic patients in comparison to age matched sample of the general population, but also found that rheumatoid arthritis patients with THA had a 3 times higher mortality risk [15]. Paavolainen found a mortality HR of 0.69 in THA patients when compared to the age and gender matched general Finnish population [13]. Barrett et al. also found that Medicare patients undergoing THA had higher 5-year survival when compared to matched (age, sex, race, and income) controls [18]. Therefore, in general it is demonstrated that patients undergoing THA have a improved survival in comparison to that of the general population [13].

Data concerning long term mortality and survival of patients undergoing TKA are less well studied. In the short term, knee arthroplasty has been reported as having a 90-day post-procedure mortality rate from 0.46% to 0.64% [9]. A recent study compared 30- and 90-day mortality rates between TKA patients treated at a single institution and those on a waiting list for surgery. Mortality from certain events, including pulmonary embolism, were expectedly higher in the TKA group [9]. A study by Ohzawa et al. found a mortality hazard ratio of 0.11 in TKA patients with OA when compared to a general population [14]. The cohort in the latter study, however, was only controlled for age and sex in a limited sample of Japanese patients [14]. Schroder et al. similarly found a beneficial effect of TKA on mortality for 1024 patients when compared to age- and sex-matched general population [11]. Although these

studies have provided valuable insight, there has been no previous study that examined long term costs and health outcomes of a large sample of TKA patients compared to OA patients who did not receive the surgery.

The long-term health benefit after arthroplasty has been partially attributed to the notion that patients receiving surgery are generally healthier than those who decide against surgery or deemed not to be candidates for surgery [9]. The latter may be true to some extent, although it has also been consistently reported that the mortality benefit of joint arthroplasty does not extend to all patient populations, including those with rheumatoid arthritis, younger patients, and those with a femoral neck fracture [13,14,17]. Specific factors speculated to affect mortality include the preoperative patient selection of healthier patients, patient activity, and the use of anti-inflammatory drugs [13]. Concerning patient selection, arthroplasty surgery may exclude patients with concomitant comorbidities [19], including cardiac and other medical conditions [14]. Our study sought to minimize this bias by controlling for disease using the Charlson Comorbidity Index, allowing an appropriate comparison with patients of similar general health [13]. Examining new disease diagnoses that were included in our study, there are a few indicators that the controlling scheme had an effect. First, it is not until the third year after surgery that a significant difference in new diagnoses of heart failure was observed. This indicates that some time was required after the index surgery until an effect was observable. It is also interesting that there is a higher risk of new diagnoses of diabetes in the 1st year after surgery, perhaps indicating that at the time of index TKA these patients were not significantly in better health.

Another strength of the current study was inclusion of control population with the same disease. Previous studies that included a control population loosely controlled for some demographic factors but did not include patients also diagnosed with knee OA. The current study used non-treated OA Medicare patients as the reference group. By including control patients with OA, and not the general population, it is ensured that patients have free access and the means to utilize healthcare through Medicare, and a demonstration that they are concerned enough with their condition to be diagnosed with OA. Also, it is plausible that both groups in the current study may have utilized medications such as anti-inflammatory drugs, which may influence survivorship of the patients and risk for downstream disease, but this could not be confirmed in the available dataset.

A goal of the methodology was to isolate the effect of activity and selected health outcomes between the arthroplasty and non-arthroplasty groups. Twenty-one million Americans have arthritis-attributable activity limitation [20]. As OA is degenerative, it is believed there is a point when it is time to move from conservative care to surgery [19]. If this point is never reached, patients with increasing pain become less active, limiting their daily exercise. Physical activity is an important part of the prevention of disability associated with OA. Inactivity associated with OA can lead to the loss of function, disability, increased risk of cardiovascular disease, and a reduced quality of life [6]. A recent study associated fatigue with

pain from OA and pain medications in a small sample of patients, and further noted that this had an effect on the mental health, physical functioning, and daily activities of OA sufferers [7]. Among other functional benefits, TKA in osteoarthritic patients has been shown to improve cardiovascular fitness [8]. The current study examined the downstream effect of improved cardiovascular fitness by examining one specific outcome of cardiovascular health, new diagnoses of heart failure. The consistently reduced incidence of heart failure, starting at 3 years after surgery, suggests that increased activity after TKA may have a beneficial effect in reducing long term cardiovascular disease among OA patients.

Patients undergoing TKA were more likely to be depressed in the first three years after surgery. At five and seven years after surgery, there was no significant difference in depression between the TKA and non-TKA groups, demonstrating a return to normal for the TKA patients. This finding suggests there should be some awareness of the mental health of TKA patients during the short term post-operative period, and appropriate treatment should be available if necessary. This information could also be used to better prepare patients for the immediate post-surgery period.

Direct medical costs for primary TKR have been previously reported to be between \$17,908 to \$22,101 [2,5,21]. The total incremental cost of \$19,843, identified by this study, agrees well with previous findings. This incremental cost, however, does not take into account the expense of prescription drugs, which has been reported to be much higher in non-arthroplasty patients. One study found the annual cost of prescription drugs to be \$1994 in large joint OA patients who avoid arthroplasty, vs. \$1261 in arthroplasty patients [22]. Another limitation of this cost analysis is that it uses reimbursement as a proxy for cost, and does not include indirect medical costs in the comparison. Indirect costs associated with OA included lost wages, lost productivity, and added expenditures for home and child care, and have been estimated to be between \$1760 to \$4603 annually [21]. Further, 9.4% of patients with OA are unable to acquire jobs because of their illness [21]. On the other hand, these costs need to be weighed against similar indirect costs incurred due to the TKA rehabilitation period. Although many indirect costs are less of a concern in Medicare patients, they provide additional perspective on the burden of OA. It has been estimated that the proportion of medical costs that are incurred due to inactivity is 12.4% in patients with OA [6]. Similarly, the proportion of medical costs for cardiovascular disease that were directly associated to inactivity were 13.1% [23]. Considering the differences in indirect costs and prescription drug costs between TKA and non-TKA patients, the incremental cost of TKA treatment is likely much less than \$19,843. From the societal level perspective, it has been concluded that it is cost effective for a patient with end-stage symptomatic OA to have a TKA procedure compared to no TKA [24], despite the higher immediate medical costs, the risk of the patient for complications, and the risk for early mortality.

The Medicare database was used in the current study for a number of reasons. First, it represents a very large patient sample, generalizable to the U.S. elderly population. Most studies on outcomes for arthroplasty patients tend to be surgeon or hospital based, and therefore have limited value for generalization [25]. Medicare patients also represent a very significant proportion of arthroplasty patients, as Medicare pays for approximately 55% of TKA procedures [21]. It has been reported that 66.4% of total arthritis related surgeries are performed in patients 65 years or older, while over half of people over the age of 65 are estimated to have arthritis [5]. Although the problem is also well suited for a randomized control trial, it is difficult to investigate the effectiveness of total knee arthroplasty compared to nonoperative care due to ethical issues [25]. Given the universal acceptance of TKA as a highly effective procedure, some may argue it inappropriate to randomize a highly disabled patient to nonoperative care [25].

Limitations of the current study are in line with other retrospective database reviews. A major drawback of using the Medicare database is that claims data lack certain details, including indices for patient pain and functioning. While a generalized comparison of TKA and non-TKA groups is a suitable analysis for this database, it is difficult to discern why some patients elected to forego arthroplasty procedures. Also confounding the data is that comorbid illnesses are suspected to be under-coded. Due to this, the methodology may miss identifying all comorbidities in patients who were not selected for surgery. Further, due to the non-specificity in the coding system, we utilized new disease diagnoses as a proxy for a patient's general health state. For example, we selected congestive heart failure as a single proxy for cardiovascular health, although we recognize there are aspects to cardiovascular health that are not captured by this single measure.

Despite the aforementioned limitations and the higher reported incidence of early mortality and affective disorders among patients undergoing TKA, this study has demonstrated that knee OA Medicare patients treated with TKA are associated with improved survivorship and reduced cardiovascular conditions.

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