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Risk Factors for Early Revision After Primary TKA in Medicare Patients

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Abstract

Background Patient, surgeon, health system, and device factors are all known to influence outcomes in total knee arthroplasty (TKA). However, patient-related factors associated with an increased risk of early failure are not well understood, particularly in elderly patients.

Questions/purposes The purpose of this study was to identify specific comorbid conditions associated with increased risk of early revision in Medicare patients undergoing TKA.

Methods A total of 117,903 Medicare patients who underwent primary TKA between 1998 and 2010 were identified from the Medicare 5% national sample administrative database and used to determine the relative risk of revision within 12 months after primary TKA as a function of baseline medical comorbidities. Cox regression was used to evaluate the impact of 29 comorbid conditions on risk of early failure controlling for age, sex, race, census region, socioeconomic status, and all other baseline comorbidities.

Results The most significant independent risk factors for revision TKA within 12 months were chronic pulmonary

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disease, depression, alcohol abuse, drug abuse, renal disease, hemiplegia or paraplegia, and obesity.

Conclusions This information could be valuable to patients and their surgeons when making shared medical decisions regarding elective TKA and for risk-stratifying publicly reported outcomes in Medicare patients undergoing TKA.

Level of Evidence Level II, prognostic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

The influence of patient, surgeon, health system, and device factors on TKA outcomes has been studied previously [1]. Previous investigators have identified younger age, male sex, lower hospital- and surgeon-procedure volumes, and use of cementless (versus cemented) TKA implants to be associated with an increased risk of revision TKA [8, 15, 19, 20]. However, little is known regarding patient-specific risk factors for early failures that occur within the first 12 months after TKA, which often result in poor clinical outcomes, particularly in elderly patients.

Elderly patients undergoing TKA frequently have multiple comorbid illnesses and are at an increased risk for perioperative morbidity and mortality [4, 12]. Previous investigators [4] have identified independent risk factors for periprosthetic joint infection and mortality after primary TKA. They found that congestive heart failure, chronic pulmonary disease, preoperative anemia, diabetes, depression, renal disease, pulmonary circulation disorders, obesity, rheumatologic disease, psychoses, metastatic tumor, peripheral vascular disease, and valvular disease are predictors of infection, and congestive heart failure, metastatic cancer, renal disease, peripheral vascular disease, cerebrovascular disease, lymphoma, cardiac arrhythmia, dementia, pulmonary circulation disorders, and chronic liver disease are associated with increased risk of mortality after primary TKA.

The purpose of this study was to identify specific comorbid conditions (adjusting for demographic factors) associated with an increased risk of revision during the first 12 months after primary TKA in Medicare patients.

Patients and Methods

The 5% sample of the Centers for Medicare & Medicaid Services Medicare claims database, which includes Part A (inpatient), Part B (physician), and outpatient claims, was used to identify patients who underwent primary TKA (International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM] code 81.53) between 1998 and 2010. Patients who were younger than 65 years of age were excluded from the study because they had major disabilities and therefore represented a population that differed from the general Medicare population. Patients who were enrolled in a health maintenance organization (HMO) were excluded because HMO claims are not available in the Medicare 5% sample database and therefore these patients would have an incomplete claims history. Patients who were not enrolled in both Part A and Part B of Medicare were also excluded because of their incomplete claim histories. Nonresidents were also excluded for the same reason.

Unique encrypted Medicare beneficiary identifiers were used to track patients longitudinally for 1 year during the 13-year study period. A linked denominator file that accompanies the analytic data sets was used to track each patient's Medicare enrollment status. This annual Medicare denominator file contains information regarding the date of death of the enrollees and was used to identify patients who died during the 1-year followup period. Revision surgery during the study period (ie, through December 31, 2010) was identified by the occurrence of the ICD-9-CM procedure codes 81.53 or 00.70–00.73 from the Part A files of the Medicare data set. We had previously found that the rate of hip implants that remained free of revision was comparable between those with known or unknown laterality ($p = 0.11$). This was also similar for knee implants ($p = 0.84$) [14].

The preoperative comorbid conditions analyzed in our study were compiled from diagnoses included in Part A, Part B, or outpatient claims submitted during the 12-month period before the primary knee arthroplasty. Only patients who had been enrolled in Medicare during the entire 12-month period before their TKA were included in the study; this ensured that a full year of baseline comorbidity information would be available for each patient. To avoid misclassification of postoperative complications as preexisting comorbid conditions, only comorbid conditions that were identified in administrative claims dated at least 30 days before the date of the index TKA were classified as preexisting conditions.

The impact of 29 comorbid conditions on the risk of revision TKA within 12 months was examined using multivariate Cox regression, controlling for age, sex, race, census region, public assistance (indicated by Medicare premiums and deductibles that were subsidized by the state because of the patient's financial status), and all other baseline comorbidities. The 29 comorbid conditions included the specific diseases that are used to determine the Charlson Comorbidity Index [6] as well as other diseases (urinary tract infection, hypercholesterolemia, anemia, drug abuse, alcohol abuse, coagulopathy, psychoses, depression,

Table 1. Demographic characteristics of the 117,903 patients undergoing primary TKA

Demographic characteristic	Total number	Percent	Total number with revision	Percent
Sex				
Female	76,914	65.2	747	60.8
Male	40,989	34.8	481	39.2
Race				
White	108,682	92.2	1,107	90.2
Black	5931	5.0	81	6.6
Others	3290	2.8	40	3.3
Age (years)				
65–69	30,957	26.3	377	30.7
70–74	35,250	29.9	361	29.4
75–79	30,074	25.5	300	24.4
80–84	16,237	13.8	153	12.5
≥ 85	5385	4.6	37	3.0
Region				
Midwest	36,009	30.5	368	30.0
Northeast	18,746	15.9	172	14.0
South	44,583	37.8	483	39.3
West	18,565	15.7	205	16.7
Public assistance status				
Public assistance	10,111	8.6	123	10.0
No public assistance	107,792	91.4	1,105	90.0
Charlson index				
0	40,769	34.6	354	28.8
1–2	51,994	44.1	555	45.2
3–4	18,819	16.0	232	18.9
≥ 5	6321	5.4	87	7.1

Table 2. Prevalence of comorbid conditions among Medicare patients undergoing primary TKA

Comorbid condition	Disease prevalence (%)
Hypertension	78.8
Hypercholesterolemia	31.3
Ischemic heart disease	31.1
Anemia	28.6
Diabetes	25.7
Cardiac arrhythmia	22.9
Malignancy	22.8
Urinary tract infection	22.5
Chronic pulmonary disease	21.9
Hypothyroidism	21.5
Valvular disease	14.8
Peripheral vascular disease	13.5
Cerebrovascular disease	12.3
Obesity	11.4
Congestive heart failure	10.9
Depression	9.8
Rheumatologic disease	8.1
Coagulopathy	7.5
Renal disease	6.6
Psychoses	4.3
Chronic liver disease	3.0
Pulmonary circulation	1.8
Peptic ulcer disease	1.6
Dementia	0.9
Lymphoma	0.9
Metastatic tumor	0.8
Alcohol abuse	0.7
Hemiplegia/paraplegia	0.4
Drug abuse	0.3

obesity, and hypothyroidism) that have been used as comorbidity indices in a previous analysis of administrative databases because of their association with increases in the length of hospital stay, hospital charges, and mortality [7]. In addition, other conditions that have been identified in previous clinical studies as risk factors for early revision TKA were included [18].

Both the crude relative risk and the adjusted hazard ratio for each comorbid condition were calculated, and the Wald chi-square statistic was used to evaluate the significance of the hazard ratio. The resulting p value for the hazard ratio was used to rank the degree of association of each comorbid condition with risk of revision surgery within 1 year after primary TKA. Thus, the ranking of a specific condition indicated the relative degree of association or significance of its presence with risk of revision surgery within 1 year after primary TKA.

A total of 117,903 Medicare patients who underwent primary TKA between 1998 and 2010 were included in the study. The mean age was 74 years (SD = 5.8), 65% were female, and 92.2% were white. Patients were geographically dispersed throughout the different US Census regions, 8.6% had public assistance for their Medicare premiums, and 78.7% had a Charlson Comorbidity Index of less than 3 (Table 1). The prevalence of each comorbid condition ranged from a high of 79% for hypertension to a low of 0.3% for drug abuse (Table 2).

Results

The cumulative incidence of revision during the first 12 months after primary TKA for the entire cohort was 1.14%. Among the comorbid conditions evaluated, the most significant independent risk factors for revision TKA within

Table 3. Results of multivariable Cox regression analysis to evaluate independent risk factors for rate of revision TKA within 12 months after primary TKA

Comorbid conditions	Risk of revision with condition (%)	Risk of revision without condition (%)	Crude relative risk (95% CI)	Adjusted hazard ratio (95% CI)	Wald's chi square	p value
Chronic pulmonary disease	1.45	1.01	1.44 (1.29–1.62)	1.32 (1.17–1.49)	19.61	< 0.0001*
Depression	1.46	1.06	1.37 (1.17–1.61)	1.30 (1.10–1.54)	9.29	0.0023*
Alcohol abuse	2.43	1.09	2.22 (1.44–3.44)	1.80 (1.15–2.83)	6.59	0.0103*
Drug abuse	2.87	1.10	2.62 (1.50–4.59)	2.08 (1.17–3.72)	6.15	0.0132*
Renal disease	1.50	1.07	1.40 (1.16–1.69)	1.25 (1.02–1.52)	4.83	0.0280*
Hemiplegia/paraplegia	2.52	1.10	2.29 (1.31–4.02)	1.91 (1.07–3.42)	4.82	0.0282*
Obesity	1.42	1.06	1.34 (1.15–1.55)	1.19 (1.01–1.39)	4.46	0.0348*
Cardiac arrhythmia	1.29	1.05	1.23 (1.09–1.39)	1.13 (0.99–1.29)	3.55	0.0596
Hypothyroidism	1.19	1.08	1.10 (1.06–2.54)	1.34 (0.86–2.11)	1.65	0.1996
Congestive heart failure	1.48	1.06	1.40 (1.21–1.63)	1.14 (0.97–1.35)	2.41	0.1206
Hypertension	1.14	1.21	1.21 (1.05–1.39)	1.12 (0.97–1.30)	2.29	0.1302
Coagulopathy	1.34	1.08	1.24 (1.03–1.49)	1.14 (0.94–1.38)	1.83	0.1759
Metastatic tumor	1.53	1.10	1.39 (1.83–2.35)	1.39 (0.82–2.38)	1.48	0.2243
Urinary tract infection	1.19	1.08	1.11 (0.98–1.25)	1.08 (0.95–1.23)	1.47	0.2258
Ischemic heart disease	1.28	1.02	1.25 (1.12–1.40)	1.08 (0.95–1.22)	1.31	0.2527
Cerebrovascular disease	1.30	1.08	1.21 (1.04–1.40)	1.08 (0.92–1.27)	0.88	0.3480
Diabetes	1.25	1.05	1.18 (1.05–1.33)	1.05 (0.93–1.19)	0.58	0.4452
Peptic ulcer disease	1.06	1.10	0.96 (0.62–1.47)	0.85 (0.55–1.31)	0.53	0.4661
Rheumatologic disease	1.21	1.09	1.10 (0.92–1.33)	1.07 (0.81–1.12)	0.40	0.5259
Anemia	1.15	1.08	1.06 (0.94–1.19)	0.96 (0.85–1.08)	0.49	0.4849
Lymphoma	1.30	1.10	1.18 (0.70–1.99)	1.21 (0.70–2.06)	0.46	0.4959
Malignancy	1.08	1.11	0.98 (0.86–1.11)	0.96 (0.84–1.10)	0.39	0.5302
Dementia	1.08	1.10	0.98 (0.56–1.73)	0.87 (0.49–1.54)	0.24	0.6250
Chronic liver disease	1.32	1.10	1.21 (0.91–1.60)	1.06 (0.79–1.42)	0.16	0.6886
Valvular disease	1.24	1.08	1.15 (1.00–1.32)	1.03 (0.88–1.20)	0.11	0.7397
Psychoses	1.30	1.09	1.19 (0.93–1.51)	0.96 (0.74–1.24)	0.11	0.7440
Pulmonary circulation	1.42	1.10	1.30 (0.91–1.85)	1.05 (0.73–1.52)	0.08	0.7817
Hypercholesterolemia	1.12	1.03	1.03 (0.92–1.15)	0.99 (0.88–1.11)	0.04	0.8355
Peripheral vascular disease	1.21	1.09	1.11 (0.96–1.29)	0.98 (0.84–1.15)	0.04	0.8433

Conditions are listed in descending order of the degree of association with revision TKA within 12 months after primary TKA based on the hazard ratio's p value; * significantly associated with an increased adjusted risk of revision within 12 months of primary TKA in these patients; CI = confidence interval.

12 months (in order of significance, $p \leq 0.04$, for all comparisons; Table 3) were chronic pulmonary disease (adjusted hazard ratio [HR], 1.32; 95% confidence interval [CI], 1.17–1.49), depression (HR, 1.30; 95% CI, 1.10–1.54), alcohol abuse (HR, 1.80; 95% CI, 1.15–2.83), drug abuse (HR, 2.08; 95% CI, 1.17–3.72), renal disease (HR, 1.25; 95% CI, 1.02–1.52), hemiplegia/paraplegia (HR, 1.91; 95% CI, 1.07–3.42), and obesity (HR, 1.19; 95% CI, 1.01–1.39). The most common overall reasons for revision TKA were infection, mechanical complication, and instability (Table 4).

Discussion

Previous investigators have characterized TKA outcomes at the population level for the Medicare population [3, 17]. It has also been documented that TKA results in decreased pain and improved function in patients who have disabling arthritis of the knee [10]. However, complications requiring revision surgery within the first 12 months after primary TKA are associated with increased costs and poor clinical outcomes. Identifying risk factors for early failure is important for informing shared medical decision-making

Table 4. Most common reasons for revision TKA

Diagnosis	Number (%)
996.66 Infection and inflammatory reaction resulting from internal joint prosthesis	342 (25.9)
996.4 Mechanical complication of internal orthopaedic device implant and graft	313 (23.7)
996.77 Other complications resulting from internal joint prosthesis	170 (12.8)
996.42 Dislocation/instability of prosthetic joint	66 (5.0)
736.6 Other acquired deformities of knee	65 (4.9)
996.47 Other mechanical complication of prosthetic joint implant	47 (3.6)
996.41 Mechanical loosening of prosthetic joint	42 (3.2)
996.43 Broken prosthetic joint implant	41 (3.1)
996.67 Infection and inflammatory reaction resulting from other internal orthopaedic device, implant, and graft	26 (2.0)
996.78 Other complications resulting from other internal orthopaedic device, implant, and graft	26 (2.0)
996.49 Other mechanical complication of other internal orthopaedic device, implant, and graft	25 (1.9)

for elderly patients who are considering elective TKA for treatment of advanced knee osteoarthritis and for risk stratification of publicly reported outcomes.

Our study has several notable limitations. First, we relied on administrative claims data (which do not indicate laterality) to identify revisions and risk factors for early failure. However, previous investigators have reported reasonable correlation between administrative claims and the clinical record when evaluating causes and types of revision total joint arthroplasties [2]. Second, our study was limited to Medicare patients; further study using different data sets will be needed to determine whether our findings are generalizable to younger patients who undergo primary TKA. Finally, our findings are limited to risk factors for failures that occur during the first 12 months after primary TKA, and therefore it is uncertain whether the same or other risk factors are associated with an increased long-term risk of revision TKA. However, the impact of patient comorbidities on the risk of early failure after TKA has important clinical and policy implications for surgeons, hospitals, and patients.

Risk factors for complications and revision after TKA have been identified by previous investigators. Mortazavi et al. [16] investigated risk factors for revision after infection after primary TKA and found revision for infection, higher Charlson index greater than 3 (odds ratio [OR], 2.48; 95% CI, 1.33–4.65), and diagnosis other than osteoarthritis (OR, 3.90; 95% CI, 1.55–9.82) at the time of primary TKA were predictors. Heck et al. [11] investigated the odds of revision TKA among Medicare patients and found that male sex, younger age, longer length of stay, more diagnoses at the time of primary TKA hospitalization, unspecified arthritis type, surgical complications during hospitalization, and surgery done at an urban hospital were all independently associated with an increased risk of revision within 2 years. Kapadia et al. [13] compared outcomes of 531 patients undergoing TKA who had a history of tobacco use with nonsmokers at a single institution and found there was a statistically significant difference in survivorship ($p < 0.001$) at the time of their most recent followup. Sheng et al. [20] found age was a predictor of survivorship of 2637 revision TKAs from the Finnish Arthroplasty Registry. Patients who were older than 70 years of age had better rates of survival ($p < 0.005$).

As healthcare delivery and payment systems shift from volume-based to value-driven [5, 9, 21], increased emphasis will be focused on public reporting of physician performance and patient outcomes, including complication and revision rates for elective surgical procedures such as TKA. Furthermore, the United States has initiated a TKA outcomes registry, the American Joint Replacement Registry, which will be used to evaluate revision rates among patients undergoing TKA in the United States. It is important that publicly reported TKA outcomes and TKA registry results be appropriately risk-adjusted for factors beyond the control of the surgeon such as patient comorbidities, which are known to influence patient outcomes. The patient comorbidities identified in our study could be used in risk-adjustment models for public reporting of TKA outcomes and total joint arthroplasty registries to appropriately account for the patient characteristics that are associated with an increased risk of revision TKA.

In conclusion, chronic pulmonary disease, depression, alcohol abuse, drug abuse, renal disease, hemiplegia or paraplegia, and obesity are associated with an increased risk of early revision after primary TKA in Medicare patients. This information can be useful in shared medical decision-making when counseling elderly patients with modifiable and non-modifiable risk factors who are considering elective TKA regarding the risk of early failure and for risk-stratifying publicly reported outcomes in Medicare patients undergoing TKA.

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