RESEARCH ARTICLE

Insurance Payer Type Affects Outcomes after Revision Total Joint Arthroplasty: A Matched Cohort Analysis

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Abstract

Background: The aim of this study is to evaluate the potential effects of insurance payer type on the postoperative outcomes following revision TJA.

Methods: A single-institution database was utilized to identify 4,302 consecutive revision THA and TKA. Patient demographics and indications for revision were collected and compared based on patient insurance payer type: (1) Medicaid, (2) Medicare, and (3) private. Propensity score matching and, subsequent, multivariate regression analyses were applied to control for baseline differences between payer groups. Outcomes of interest were rates of complications occurring perioperatively and 90 days post-discharge.

Results: After propensity-score-based matching, a total of 2,328 patients remained for further multivariate regression analyses (300 [12.9%] Medicaid, 1022 [43.9%] Medicare, 1006 [43.2%] private). Compared to privately insured patients, Medicaid and Medicare patients had 71% (*P<0.01)* and 53% *(P=0.03)* increased odds, respectively, for developing an in-hospital complication. At 90 days post-discharge, compared to privately insured patients, Medicaid and Medicare patients had 88% and 43% odds, respectively, for developing overall major complications.

Conclusion: Our propensity-score-matched cohort study found that, compared to privately insured patients, patients with government-sponsored insurance were at an increased risk for developing both major or minor complications perioperatively and at 90-days post-discharge for revision TJA. This suggests that insurance payer type is an independent risk factor for poor outcomes following revision TJA.

Level of evidence: III

Keywords: Clinical outcomes, Insurance payer type, Revision surgery, Total joint arthroplasty

Introduction

Recent literature has described various factors associated with complications and poor outcomes following primary total hip and knee joint arthroplasty (TJA). There is increasing attention to psychosocial and socioeconomic factors, such as mental health status, income level, hospital type, and race (1). Insurance, a proxy for socioeconomic status, has been shown to have significant influence on postoperative outcomes following primary TJA (2). In the United States, Medicaid is a public assistance program for low-income

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individuals regardless of their age, while Medicare is an age-based federal health insurance program that guarantees coverage for individuals aged 65 and over and some younger people with disabilities. Both insurance programs are used to pay for healthcare and medical expenses (3). Private insurance generally refers to health insurance that is purchased through a private company or offered through an employer and is not provided by a state or federal government. In the USA, currently 91.1% of individuals have health insurance. Of these insured individuals, 68.6%, 20.5%, and 17.6% are insured through private, Medicare, or Medicaid health insurance, respectively.

A recent study showed that Medicare insurance was associated with significantly higher risk for in-hospital complications following primary THA, including mortality, wound dehiscence, and central nervous system and gastrointestinal complications, compared to private insurance (4). Medicaid patients have been reported to have a higher prevalence of postoperative in-hospital infection, wound dehiscence, and hematoma compared to non-Medicaid patients following primary TJA (5). These studies however are derived from the Nationwide Inpatient Sample, a large database with no data available for follow-up rates, readmissions, or delayed post-discharge complications. Nevertheless, such studies, along with studies from other surgical disciplines, underline the importance of considering the insurance status when evaluating patients that are due to undergo revision surgery (6).

In revision TJA, recent literature has focused on predictors of revision outcomes with emphasis on surgical technique, implant parameters, and individual patient clinical factors. However, there is a paucity of literature evaluating the impact of socioeconomic factors on revision TJA outcomes. In light of the expected increases in revision TJA and the subsequent post-surgical complications, it is important to understand the impact of such factors on poor outcomes, so that healthcare systems can adapt and provide personalized care for patients of varying socioeconomic strata (7). The aim of this study is to evaluate the potential impact of insurance payer type on postoperative outcomes in revision TJA.

Materials and Methods

Patients

After obtaining approval from the Institutional Review Board, we retrospectively evaluated a total of 4,302 consecutive patients who underwent either revision THA or TKA at our academic tertiary referral center. For this study, a revision TJA was considered as the revision or exchange of one or more nonmodular components (hips: acetabular shell, femoral stem; knees: femoral, tibial and patellar components) and/or one or more modular components (hips: acetabular liner, femoral head; knees: polyethylene insert). From this total, we excluded patients if they had met at least one of the following criteria: (1) missing or unknown perioperative information, (2) unknown insurance status, (3) previous revisions of the joint or any operation within three months of revision TJA, or (4) lost to a minimum follow-up of two years. A total of 3,888 patients remained after these exclusion criteria. These patients were divided into three cohorts depending on their insurance status: (1) Medicaid, (2) Medicare, and (3) private. These insurance groups had 348 (9.0%), 1812 (46.6%), and 1728 (44.4%) patients, respectively, and these classifications have been previously utilized when investigating associations between socioeconomic status and surgical outcomes4,5comorbidities, and complications were collected and compared based on insurance type. Multivariable logistic regression and a matched cohort analysis were performed.Results:About 515,037 patients (53.7% Medicare, 40.1% private insurance, 3.9% Medicaid/uninsured, and 2.2% other. All patients were tracked using the electronic medical record system at our institution. Demographic variables, including age, sex, race, body mass index (BMI), social history, and comorbidities, American Society of Anesthesiologists (ASA) score, and indications for revision THA/TKA were prospectively collected for each included patient. An overall morbidity factor for each patient was also calculated according to Charlson comorbidity index (CCI) criteria (8). The demographics for the patients in the three insurance cohorts are summarized in [Table 1].

Raw Cohorts

The demographics for the patients in the three insurance cohorts are summarized in [Table 1]. Patients in the Medicaid cohort were significantly younger than those with private insurance (mean ages of 55.8 and 61.4 years at the time of revision surgery, respectively). The Medicare cohort had the oldest patients on average with a mean age of 71.5 years. In addition to age, the unmatched groups presented significant differences in gender, race, body mass index (BMI), social history, CCI, and several comorbidities. Indications for revision surgery and surgical data are shown in [Table 2]. Revision THA comprised the largest portion of revision TJA in every cohort; however, the proportion of THAs to TKAs, as well as laterality, remained statistically similar in the initial cohorts. Several indications for revision TJA, including wear and osteolysis, instability, dislocation, adverse local tissue reaction, and stiffness, were significantly different (all $P<0.05$) when comparing all three groups. However, aseptic loosening and periprosthetic joint infection (PJI) represented the two most common etiologies for revision TJA in all cohorts. Anesthesia type between initial cohorts was also statistically similar prior to matching, in which, general anesthesia was administered in the largest proportion compared to spinal anesthesia.

Cohort Matching

Propensity score matching was used to match the three insurance groups based on health status covariates potentially associated with the type of insurance as well as postoperative outcomes. In concordance with previous literature, we employed generalized propensity scores to balance the covariates among the three insurance cohorts and match based on: (1) age, (2) gender, (3) race, (4) BMI,

Table 1. Patient Demographics of Raw Cohorts

	Group A: Medicaid/Uninsured (N=348)	Group B: Medicare (N=1,812)	Group C: Private Insurance (N=1,728)	*P value* (A vs. B vs. C)
Age Distribution				**<0.001**
<40	3.3	0.3	20.4	
40-64	76.3	18.4	68.4	
65-79	17.2	66.4	23.6	
>80	3.3	14.9	5.4	
Mean Age	55.8±7.3	71.5±9.4	61.4±9.5	
Gender				**<0.001**
Male	47.8	48.3	52.7	
Female	52.2	51.7	47.3	
Race				**<0.001**
White	88.5	92.0	91.7	
Black	10.0	5.3	3.6	
Other	1.4	2.7	4.7	
BMI Distribution (%)				**<0.001**
≤24	4.3	109	7.8	
25-29	28.2	32.0	34.5	
30-34	35.9	32.3	30.2	
≥35	31.6	29.4	27.6	
Mean BMI	32.9±7.5	30.0±8.3	29.5±8.1	
Social History (%)				**<0.001**
Smoking	16.7	6.1	9.7	
Alcohol use	34.9	21.4	30.7	
Drug use	2.4	0.6	1.1	
Charlson Comorbidity Index (CCI)				**<0.001**
0-1	25.4	6.4	20.4	
2	44.0	26.9	28.5	
3	23.0	46.3	40.7	
≥4	7.7	30.5	10.3	
Mean CCI	2.3±1.2	3.3±2.0	2.4±1.3	
Comorbidities (%)				
Depression	21.0	15.6	13.3	**0.007**
Hypertension	54.6	56.3	50.3	0.078
Chronic Pulmonary Disease	23.0	16.8	14.2	**0.003**
Vascular Disorders	48.3	56.9	53.4	**0.014**
Diabetes	25.9	20.4	19.4	0.096
Hypothyroidism	17.5	19.5	14.5	**<0.001**
Preoperative Blood Markers				
Hb, g/dL	13.5±1.5	13.6±1.6	13.6±1.4	0.540
Hct, %	41.9±3.1	41.2±3.3	41.4±3.2	0.763
Platelet count, 10^9/L	173.8±40.8	173.1±44.2	172.6±49.8	0.832

(5) ASA score, (6) CCI, and (7) indications for revision (9). If the generalized propensity scores are well estimated, then the propensity-score-weighted populations should be balanced with respect to the covariates, thus removing the contribution of health status differences to disparities in insurance. Our generalized propensity scores were defined as the conditional probability of having Medicare insurance, which were generated using a multinomial logistic regression including the main effects of all covariates with an applied generalized overlap weighting scheme. This particular weighting scheme emphasizes naturally comparable cohorts that are most typical in each respective group. This process was performed in accordance with the tutorial on propensity score estimation for multiple treatments by McCaffrey et al. (9). Although propensity score matching for multiple groups does not typically result in even 1:1 or 1:k (k = integer) group ratios as in two-group matching, the resulting matched groups result in a more favorable reduction of selection bias and adequately balanced health status variables.

Postoperative Outcomes and Complications

The primary outcomes were in-hospital complications that occurred during patients' stays after revision TJA and complications that occurred within 90 days of discharge. Complications occurring within 90-days postoperatively were also categorized as either "major" or "minor" according to prior TJA literature and analyzed accordingly (10). Allogenic blood transfusions were provided intraoperatively if patients' hemoglobin (Hb) level was less than 8.0 g/dL. Postoperatively, patients were transfused if their Hb level was less than 9.0 g/dL or if they presented any obvious anemic symptoms. Minor complications included pneumonia, blood loss requiring transfusion, urinary tract infection, renal insufficiency, and superficial surgical site infection. Major complications included unplanned intubation, wound dehiscence, deep surgical site infection, hematoma or seroma, myocardial infarction, shock, sepsis, stroke, deep venous thrombosis, pulmonary embolism, reoperation, and mortality. Aggregates of minor and major complications were additionally evaluated. Readmissions occurring within 30, 60, and 90 days for these complications were also collected. Re-revisions for aseptic and septic failures were evaluated until the latest follow-up, with a septic failure defined as an occurrence of periprosthetic joint infection.

Table 2. Revision Details of Raw Cohorts

	Group A: Medicaid/Uninsured (N=348)	Group B: Medicare (N=1,812)	Group C: Private Insurance (N=1,728)	*P value* (A vs. B vs. C)
Revised Joint (%)				0.472
Hips	54.1	58.5	58.0	
Knees	45.9	41.5	42.0	
Laterality (%)				0.076
Left	47.8	48.3	52.7	
Right	52.2	51.7	47.3	
Indications for Revision (%)				
Aseptic Loosening	26.7	24.4	27.3	0.678
Periprosthetic Joint Infection	23.5	26.3	21.4	0.114
Wear and Osteolysis	10.5	13.2	12.0	**0.001**
Instability	12.0	9.0	11.4	**0.003**
Periprosthetic Fracture	11.0	9.4	8.5	0.211
Dislocation	5.7	8.0	7.5	**0.002**
Adverse Local Tissue Reaction	4.3	8.0	7.7	**<0.001**
Stiffness	1.9	6.6	5.3	**<0.001**
Other	7.8	10.5	8.4	0.722
Anesthesia (%)				0.785
General	82.4	82.8	79.8	
Spinal	17.6	17.2	20.2	
Intravenous Tranexamic Acid Usage (%)	73.9	71.8	73.8	0.379
Case Length, min	171.6±65.3	166.2±49.3	169.3±44.7	0.063

Secondary outcomes included length of stay (LOS) and discharge disposition.

Statistical Analysis

Propensity score matching was performed in R (R Core Team, 2017, Vienna Austria) with the use of the PSWeight package. After propensity analysis, Analysis of Variance (ANOVA) statistics were performed with the use of Statistical Package for Social Sciences version 25.0 (IBM Corp. Released 2019; IBM SPSS Statistics for Windows, Version 25.0 Armonk, NY) with follow up Tukey tests to correct for cohort matching. Multivariate regression analyses, which were adjusted for propensity scores and clinical covariates, were then applied to the total matched cohort to obtain adjusted odds ratios (OR) and mean differences. Level of significance was $P < .05$ for all analyses.

Results

Matched Cohorts

Out of the total 3,888 patients in the raw cohorts, propensity score matching resulted in 2,328 patients, who were divided into three cohorts consisting of 300 (12.9%), 1006 (43.2%), and 1022 (43.9%) patients in the Medicaid, Medicare, and private insurance cohorts, respectively. The demographics and revision TJA details of the matched cohorts are described in [Table 3]. Age was the only covariate that could not be matched or balanced after propensity score matching there is an inherent age difference based on insurance type as Medicare is an age-based federal health insurance program that guarantees coverage for individuals aged 65 and over. Multivariate logistic regression analyses were subsequently applied to the propensity-score-matched cohorts to further adjust for age as well as other patient and procedure characteristics.

Medicaid versus Medicare Insurance

Compared to Medicaid patients, Medicare patients had similar odds for generally developing one or more in-hospital complications. Postoperative transfusion due to acute blood loss anemia was the most common complication experienced in both cohorts (Medicaid: 12.0%, Medicare: 9.5%, *P=0.208*). Medicare patients were at higher risk for experiencing acute cardiac events (arrythmia, tachycardia, ventricular fibrillation,

Table 3. Patient Demographics and Revision Details of Matched Cohorts

	Group A: Medicaid (N=300)	Group B: Medicare (N=1022)	Group C: Private Insurance (N=1006)	*P value* (A vs. B vs. C)
Age	58.6±6.9	65.3±8.1	62.3±7.5	**<0.001**
BMI	30.5±7.9	30.3±6.4	30.2±7.1	0.778
ASA score	2.2±1.3	2.4±1.2	2.3±1.3	0.117
CCI	2.7±1.4	2.9±1.4	2.7±1.6	0.108
Gender (%)				0.904
Male	50.0	49.5	50.6	
Female	50.0	50.5	49.4	
Race				0.403
White	91.7	93.7	94.0	
Black	7.2	4.1	3.6	
Other	1.1	2.2	2.5	
Social History (%)				0.114
Smoking	9.1	6.2	8.8	
Alcohol use	21.3	22.5	23.2	
Drug use	2.3	0.6	1.2	
Comorbidities (%)				
Depression	17.0	14.8	15.8	0.731
Hypertension	56.0	54.6	54.3	0.960
Chronic Pulmonary Disease	12.7	13.2	13.7	0.939
Vascular Disorders	47.3	53.7	51.1	0.688
Diabetes	26.0	24.5	25.0	0.917
Hypothyroidism	18.3	19.5	20.0	0.856
Preoperative Blood Markers				

Table 3. Continued

Hb, g/dL	13.4±1.7	13.4±1.4	13.5±1.5	0.728
Hct, %	40.9±2.9	41.2±3.6	41.3±3.2	0.114
Platelet count, 10^9/L	175.3±36.4	173.2±45.9	171.6±38.1	0.195
Revised Joint				0.368
Hips	56.8	57.0	53.8	
Knees	43.2	43.0	46.2	
Laterality				0.907
Left	48.9	50.2	50.9	
Right	51.1	49.8	49.1	
Indications for Revision (%)				
Aseptic Loosening	26.5	27.4	25.4	0.963
Periprosthetic Joint Infection	23.4	25.6	21.3	0.884
Wear and Osteolysis	11.5	12.1	12.5	0.958
Instability	9.1	10.2	11.7	0.520
Periprosthetic Fracture	9.5	9.0	10.9	0.862
Dislocation	6.8	7.2	7.5	0.970
Adverse Local Tissue Reaction	4.3	8.0	7.7	0.876
Stiffness	2.3	3.2	2.7	0.121
Other	4.6	4.5	3.8	0.562
Anesthesia (%)				0.799
General	80.3	83.1	81.4	
Spinal	19.7	16.9	18.6	
Intravenous Tranexamic Acid Usage (%)	74.7	72.7	74.4	0.649
Case Length, min	170.4±57.3	168.5±41.3	168.8±36.2	0.784

myocardial infarction, etc.) than Medicaid patients (OR=2.54, *P<0.05*). Medicare patients experienced a longer length of stay (Medicaid: 3.6 days, Medicare: 4.2 days, *P<0.001*) and were more frequently discharged to in-patient rehabilitation centers (Medicaid: 3.7 %, Medicare: 10.2 %, P<0.001), while Medicaid patients were more frequently discharged to home (Medicaid: 72.6 %, Medicare: 65.7%, P=0.025) [Tables 4; 5].

Medicare versus Private Insurance

Compared to privately insured patients, Medicare patients had greater odds of developing two or more in-hospital complications (OR=1.67, *P=0.004*). Although individual incidence rates of common in-hospital complications were generally higher in the Medicare cohort, they were not statistically different between the Medicare and private insurance cohorts. The most common in-hospital complications were acute blood loss anemia requiring allogenic blood transfusion (Medicare: 9.5%, Private: 8.0%, *P=0.235*) and acute cardiac events (Medicare: 4.2%, Private: 2.9%, *P=0.116*). Medicare patients experienced a longer length of stay (Medicare: 4.2 days, Private: 3.2 days, *P<0.001*) and were more frequently discharged to skilled nursing facilities (Medicare: 4.2 days, Private: 3.2 days, *P<0.001*) and in-patient rehabilitation centers (Medicare:10.2%, Private: 6.9%, *P=0.008*), while privately insured patients were more frequently discharged to home (Medicare: 72.6%, Private: 78.1%, *P<0.001*). Although 30-, 60-, and 90-day readmissions were generally higher in the Medicare cohort, both cohorts shared statistically similar readmissions. The Medicare cohort was at higher overall odds for developing major complications at 90-days post-discharge, with deep surgical site infection (OR=3.57, *P=0.009*) representing a particularly significant complication in this population [Table 6].

Medicaid versus Private Insurance

Compared to privately insured patients, Medicaid patients had higher odds for developing an in-hospital complication (OR=1.53, P=0.026), with acute blood loss anemia requiring transfusion representing the most frequent in-hospital complication (OR=1.57, *P=0.034)*. Medicaid patients experienced longer average length of stays (Medicaid: 3.6 days, Private: 4.2 days, *P<0.001*)

Table 4. Perioperative Outcomes Between Propensity-Score-Matched Cohorts

	Medicaid	Medicare	Private
In-hospital Postoperative Complications (%)			
0 complications	77.5	74.3	85.5
1 complication	15.2	16.7	10.5
2+ complications	7.2	9.0	5.6
Common In-hospital Complications (%)			
Transfusions	12.0	9.5	8.0
Acute Cardiac Events	1.7	4.2	2.9
Venous Thromboembolism	1.3	2.6	1.8
Wound drainage	3.3	3.1	2.6
Hypotension	3.0	3.5	2.9
Length of stay, days	3.6±2.0	4.2±2.1	3.2±1.9
Discharge Disposition (%)			
Home	72.6	65.7	78.1
Skilled nursing facility	23.7	24.1	15.0
In-patient rehabilitation	3.7	10.2	6.9

and were more frequently discharged to skilled nursing facilities (Medicaid: 24.1%, Private: 15.0%, *P<0.001*), while patients with private insurance were more frequently discharged home (Medicaid: 3.7%, Private: 6.9%, *P=0.048*) and to in-patient rehabilitation services (Medicaid: 3.7%, Private: 6.9%, *P=0.046*) [Table 7]. Medicaid patients had significantly higher odds for 90-day readmissions (OR=1.31, *P=0.310*) compared to privately insured patients. Additionally, Medicaid patients were at higher overall odds for developing major complications at 90-days post-discharge, with wound dehiscence (OR=5.65, *P=0.001*) and deep surgical site infection (OR=3.57, *P=0.009*) representing the most significant complications.

Table 5. Odds Ratios for Perioperative Outcomes

	Medicare vs. Medicaid Adj. OR (95% CI)	*P-value*	Medicare vs. Private Adj. OR (95% CI)	*P-value*	Medicaid vs. Private Adj. OR (95% CI)	*P-value*
In-hospital Postoperative Complications						
0 complications	0.84 (0.62-1.14)	0.264	0.49 (0.49-0.76)	<0.001	0.73 (0.53-1.00)	0.046
1 complication	1.12 (0.78-1.60)	0.548	1.71 (1.32-2.22)	<0.001	1.53 (1.05-2.22)	0.026
2+ complications	1.27 (0.78-2.08)	0.334	1.67 (1.02-1.97)	0.004	0.92 (0.56-1.50)	0.745
Common In-hospital Complications						
Transfusions	0.77 (0.51-1.16)	0.208	1.21 (0.89-1.64)	0.235	1.57 (1.03-2.38)	0.034
Acute Cardiac Events	2.54 (1.01-6.41)	0.049	1.47 (0.91-2.37)	0.116	0.58 (0.22-1.50)	0.263
Venous Thromboembolism	2.03 (0.69-5.91)	0.197	1.46 (0.80-2.66)	0.224	0.72 (0.24-2.16)	0.568
Wound drainage	0.94 (0.45-1.94)	0.480	1.20 (0.71-2.03)	0.510	1.28 (0.61-2.69)	0.528
Hypotension	1.17 (0.56-2.46)	0.508	1.21 (0.74-2.00)	0.452	1.04 (0.48-2.21)	0.934
Length of stay, days	-0.6 (-0.2 - -1.0)	<0.001	+1.0 (+0.5-+1.5)	<0.001	+0.4 (+0.2-+0.6)	<0.001
Discharge Disposition						
Home	0.72 (0.54-0.96)	0.025	0.54 (0.44-0.65)	<0.001	0.74 (0.55-1.00)	0.048
Skilled nursing facility	1.02 (0.76-1.38)	0.895	1.80 (1.44-2.25)	<0.001	1.76 (1.28-2.42)	0.001
In-patient rehabilitation	2.96 (1.57-5.57)	0.001	1.53 (1.12-2.10)	0.008	0.52 (0.27-0.99)	0.046

Table 6. Comparison of Readmissions, 90-day, and Re-revisions Between Propensity-Score-Matched Cohorts

	Medicaid	Medicare	Private
Readmissions (%)			
30-day	10.7	9.4	8.5
60-day	15.3	15.1	14.6
90-day	22.6	19.8	16.1
90-day Minor Complications (%)			
All minor complications	5.6	5.1	4.5
Pneumonia	1.1	1.6	1.0
Urinary tract infection	1.1	1.6	1.2
Renal insufficiency	1.1	0.5	1.3
Superficial surgical site infection	2.3	1.4	1.0
90-day Major Complications (%)			
All major complications	21.3	17.1	12.6
Unplanned intubation	2.0	1.4	1.2
Wound dehiscence	3.3	1.7	0.6
Hematoma/Seroma	2.3	1.6	1.5
Deep surgical site infection	4.1	2.8	0.8
Myocardial infarction	1.1	0.8	0.7
Shock	1.1	0.3	0.5
Sepsis	1.1	0.5	0.8
Stroke	0.7	1.3	1.4
Deep venous thrombosis	0.0	0.9	0.8
Pulmonary embolism	1.1	0.7	0.8
Reoperation	4.5	4.7	3.3
Death	0.0	0.4	0.2
Re-revisions (%)			
Aseptic Failures	10.2	11.0	9.3
Septic Failures	6.0	4.3	3.2

Table 7. Odds Ratios for Readmissions, 90-day Post-discharge Complications, and Re-revisions

	Medicaid vs. Medicare Adj. OR (95% CI)	*P value*	Medicare vs. Private Adj. OR (95% CI)	*P value*	Medicaid vs. Private Adj. OR (95% CI)	*P value*
Readmissions						
30-day	1.15 (0.76-1.76)	0.514	1.12 (0.72-1.74)	0.640	1.29 (0.84-1.98)	0.246
60-day	1.02 (0.71-1.45)	0.988	1.14 (0.80-1.62)	0.478	1.06 (0.74-1.51)	0.777
90-day	1.18 (0.87-1.61)	0.295	1.29 (0.93-1.79)	0.134	1.52 (1.11-2.09)	**0.010**
Minor Complications						
All minor complications	1.10 (0.63-1.94)	0.745	1.14 (0.63-2.06)	0.677	1.26 (0.71-2.24)	0.440
Pneumonia	0.68 (0.21-2.25)	0.543	1.61 (0.54-4.80)	0.400	1.10 (0.32-3.83)	0.889
Urinary tract infection	0.68 (0.21-2.25)	0.543	1.34 (0.46-3.88)	0.603	0.92 (0.27-3.11)	0.896
Renal insufficiency	2.21 (0.55-8.89)	0.266	0.38 (0.07-2.07)	0.268	0.84 (0.25-2.84)	0.797

Table 7. Continued						
Superficial surgical site infection	1.66 (0.66-4.15)	0.284	1.41 (0.45-4.41)	0.571	2.33 (0.88-6.18)	0.088
Major Complications						
All major complications	1.31 (0.95-1.81)	0.097	1.43 (1.01-2.04)	**0.046**	1.88 (1.35-2.62)	**<0.001**
Unplanned intubation	1.44 (0.55-3.76)	0.469	1.17 (0.38-3.57)	0.796	1.68 (0.63-4.50)	0.306
Wound dehiscence	1.97 (0.89-4.35)	0.092	2.87 (0.88-9.34)	0.080	5.65 (2.05-15.61)	**0.001**
Hematoma/Seroma	1.45 (0.59-3.56)	0.428	1.07 (0.38-3.00)	0.909	1.55 (0.62-3.83)	0.353
Deep surgical site infection	1.48 (0.75-2.93)	0.259	3.57 (1.35-9.44)	**0.009**	5.30 (2.17-12.96)	**<0.001**
Myocardial infarction	1.38 (0.38-4.98)	0.637	1.14 (0.26-4.96)	0.867	1.58 (0.43-5.85)	0.505
Shock	3.70 (0.78-17.59)	0.100	0.60 (0.06-5.65)	0.667	2.21 (0.55-8.89)	0.266
Sepsis	2.21 (0.55-8.89)	0.266	0.62 (0.11-3.57)	0.608	1.38 (0.38-4.98)	0.637
Stroke	0.54 (0.12-2.31)	0.409	0.93 (0.30-2.86)	0.904	0.50 (0.12-2.13)	0.351
Deep venous thrombosis	-	-	1.13 (0.28-4.48)	0.876	-	-
Pulmonary embolism	1.58 (0.43-5.85)	0.505	0.87 (0.19-4.00)	0.872	1.38 (0.38-4.98)	0.637
Reoperation	0.96 (0.52-1.77)	0.894	1.45 (0.77-2.73)	0.259	1.38 (0.72-2.63)	0.332
Death	-	-	2.00 (0.21-19.16)	0.558	-	-
Re-revisions						
Aseptic Failures	0.92 (0.60-1.40)	0.708	1.21 (0.79-1.83)	0.389	1.11 (0.72-1.70)	0.653
Septic Failures	1.42 (0.81-2.50)	0.225	1.36 (0.70-2.62)	0.366	1.93 (1.07-3.48)	**0.029**

Discussion

Insurance type has been previously shown to be an independent risk factor for several postoperative outcomes, including complications following major surgical operations, including primary total joint arthroplasty (4, 5, 11). This propensity-score-based matched cohort study demonstrated that insurance payer type in revision TJA is independently associated with increased perioperative complications, length of stay, 90-day readmissions, 90 days post-discharge complications, and re-revision surgery for PJI. We report higher odds for developing deep surgical site infection in Medicare and Medicaid patients following revision TJA than reported in primary TJA (4).

Our study demonstrated that patient insurance type significantly correlated with hospital length of stay. Specifically, out of the three cohorts, Medicare patients had the longest mean length of stay (>4 days) followed by Medicaid patients (>3.5 days) and privately insured patients (3.2 days). We also report longer lengths of stay for these three cohorts following revision TJA than what has been reported previously in primary TJA, ranging between 2.28 (Private) to 2.73 days (Medicare) (12). These findings are likely to be explained by the increased perioperative morbidity and patient complexity associated with revision TJA relative to primary TJA.

Although Medicaid and Medicare patients were readmitted more frequently on average than privately insured patients, we found that readmissions within 30 and 60 days after revision TJA were not statistically different between the three insurance cohorts. This novel finding may suggest that the medical burden of revision arthroplasty may outweigh the socioeconomic disparities often associated with varying insurance types, which has been shown to cause differences in 30- and 60-day readmissions in primary TJA (13). Revision TJA is technically more challenging than primary TJA and often involves more soft tissue dissection and bone loss. As such, greater overall postoperative morbidity than in primary TJA is expected and has been shown (14). This may, in part, explain the reason the 30-, 60-, and 90-day readmissions rates in our patients are significantly higher than the readmission rates reported in comparable studies in the primary TJA literature5,13costs, and length of hospital stay for patients with Medicaid were compared with those for non-Medicaid patients. Each Medicaid patient was matched to a non-Medicaid patient according to age, sex, race, type of total joint arthroplasty, procedure year, hospital characteristics, smoking status, and all twenty-nine comorbidities defined in the NIS-modified Elixhauser co-morbidity measure.\nResults: It was determined that 191,911 patients who underwent total joint arthroplasty had Medicaid payer status (2.8% of the entire total joint arthroplasty population and the less meaningful association between insurance status and early readmission rates (30- and 60-day) in revision TJA. However, at the 90-day period, our results are consistent with the existing literature in that Medicaid patients have significantly higher odds of readmission than privately insured patients (15).

We found postoperative complication rates to vary significantly by insurance type. Medicaid and Medicare patients were at a higher risk of both major and minor

complications than privately insured patients. Similar observations were made in a recent study by Veltre et al., investigating the effect of insurance status on complication rates in patients following primary THA. The authors reported that patients with Medicare and Medicaid had significantly higher aggregated incidences of medical and surgical complications following primary THA when compared to patients with private insurance. The same study highlighted that acute cardiac events represent the most commonly observed post-surgical major complication with an incidence rate of 6% in Medicare patients, which is 43% greater than our reported incidence rate for acute cardiac events occurring perioperatively (4.2%) (4). Perioperative acute blood loss anemia requiring blood transfusions represented the most common complication in our study. Saleh et al. found that Medicaid insurance, when compared to private insurance, was associated with a 58% increase in odds of receiving an allogenic blood transfusion following primary THA, which closely parallels our own finding of 57% increased risk following revision TJA (16).

In a retrospective study of primary TJA by Browne et al, Medicaid patients were demonstrated to have significantly higher odds for postsurgical infection, wound dehiscence and hematoma than non-Medicaid patients (5). While the study by Browne et al. demonstrated a prevalence of postsurgical infection and wound dehiscence of 0.5% in primary TJA, the present study reported a much higher incidence of deep surgical site infection of 4% following revision TJA. Additionally, the current study found that Medicaid and Medicare insurance status was associated with 465% and 187% increased odds, respectively, for wound dehiscence compared to privately insured patients. The low prevalence of infection and wound dehiscence reported by Browne et al. may be underestimated as their database only reports inpatient data rather than 90-day follow-up. Additionally, when compared to private insurance patients, Medicaid patients were more likely to have septic failure, or periprosthetic joint infection, following revision TJA. Because periprosthetic joint infection is a particularly devastating and expensive complication, it is important to note its increased rate following revision TJA compared to primary TJA and in patients with Medicaid compared to private insurance.

The differences in postoperative complications based on insurance type may be attributable to significant differences in age between both cohorts – Medicaid patients in our cohort were on average significantly younger than privately insured patients (~4 years). The difference in complications rates may be secondary to the observation that younger patients needing revision TJA often present with more significant pathology than their elderly counterparts. However, Medicare and Medicaid patients – the largest age gap in the present study – demonstrated statistically similar postoperative outcomes and complication rates upon discharge after revision surgery. Both cohorts were significantly more likely to develop major complications than privately insured patients. Additionally, the difference in postoperative complications based on insurance type may be associated with the socioeconomic status heavily influencing outcomes in TJA (4, 17). McMorrow et al. showed that Medicaid patients receive fewer preoperative diagnostic studies than privately insured patients, which may predispose them to missed comorbidities (17). Lack of medical optimization preoperatively increases the risk of postoperative complications (5). Additionally, Medicaid patients may have more limited access to resources that may aid with postoperative recovery, thereby increasing the risk of poorer outcomes. Pre-existing conditions and chronic diseases are also more prevalent among the Medicaid population and place these individuals at increased risk of complication (18). We did not specifically look at nutrition laboratory markers prior to revision TJA, but it may be interesting to note how values like albumin and total lymphocyte count vary between those with government-sponsored (Medicare or Medicaid) and private insurance. Whether it is related to limited access to preoperative optimization, overall higher rate of comorbidities, poor nutrition, limited postoperative resources, or difficulty adhering to postoperative protocols, it is clear that individuals with government insurance have a higher rate of complications at 90 days following revision TJA. Socioeconomic status and access to insurance have long been shown to contribute to healthcare disparities in the United States of America. In this case, insurance type, as a proxy for socioeconomic status, is associated with higher complications and worse outcomes following revision TJA. The overall aggregated incidence rates of major and minor complications in this study (19% and 15%, respectively) are higher than those reported in prior studies in primary TJA (11-14% and 8-12%, respectively) (4, 5). Therefore, revision surgery outcomes may be improved through enhanced patient education, clear post-discharge paperwork, patient liaisons to address specific concerns, pre-operative visits with primary care physicians, among other initiatives.

Our study poses several inherent limitations given its retrospective nature. First, there are limitations of using a database associated with the quality of the data evaluated retrospectively. However, the present study was based on a prospectively collected database. Second, our propensity matching was not able to match the cohorts for age. This was due to the fact that the Medicare program has an age restriction (≤ 65) that is required to be met for eligibility. Age can influence a number of different postoperative outcomes following arthroplasty. However, this is a common limitation to many studies in the existing literature that evaluate insurance type on treatment outcomes (19). In order to account for the age discrepancy after propensity score matching, multivariate regression analyses were used to control for this factor. However, this assumes that effect of age on outcomes can be controlled linearly.

In conclusion, our propensity-score-matched cohort study found that, compared to privately insured patients, patients with government-sponsored insurance (Medicare or Medicaid) were at an increased risk for

developing complications perioperatively and at 90-days post-discharge for revision TJA. Our results suggest that insurance payer type, a proxy for socioeconomic status, is an independent risk factor for poor outcomes after revision TJA.

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