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SYMPOSIUM: COMPLICATIONS OF HIP ARTHROPLASTY

Factors That Predict Short-term Complication Rates After Total Hip Arthroplasty

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Abstract
Background There remains uncertainty regarding the relative importance of patient factors such as comorbidity and provider factors such as hospital volume in predicting complication rates after total hip arthroplasty (THA).
Purpose We therefore identified patient and provider factors predicting complications after THA.
Methods We reviewed discharge data from 138,399 patients undergoing primary THA in California from 1995 to 2005. The rate of complications during the first 90 days postoperatively (mortality, infection, dislocation, revision, perioperative fracture, neurologic injury, and thromboembolic disease) was regressed against a variety of independent variables, including patient factors (age, gender, race/ethnicity, income, Charlson comorbidity score) and provider variables (hospital volume, teaching status, rural location).
Results Compared with patients treated at high-volume hospitals (above the 20th percentile), patients treated at low-volume hospitals (below the 60th percentile) had a higher aggregate risk of having short-term complications (odds ratio, 2.00). A variety of patient factors also had associations with an increased risk of complications: increased Charlson comorbidity score, diabetes, rheumatoid arthritis, advanced age, male gender, and black race. Hispanic and Asian patients had lower risks of complications.
Conclusions Patient and provider characteristics affected the risk of a short-term complication after THA. These results may be useful for educating patients and anticipating perioperative risks of THA in different patient populations.
Level of Evidence Level II, prognostic study. See Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.
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Introduction

THA is effective for decreasing pain and improving the function of patients with arthritis refractory to nonoperative treatment with antiinflammatory medications, activity modification, and weight loss. Despite the efficacy of THA, complications can occur which result in poor functional outcomes for a subset of patients. Given hip arthroplasty is a common and costly procedure, documenting and improving the quality of care and outcomes after THA remains a priority. Identifying risk factors that predict postoperative complications and, more specifically, being able to predict those patients at higher risk before surgery is an important step in searching for strategies that might reduce short-term complication rates.

The most common major complications include mortality, infection, dislocation, revision, and pulmonary embolism [4–6]. The rates of complication have been reported in international registries [2, 3, 8]. In addition, several papers have used administrative databases to evaluate complications in Medicare patients, with emphasis on the relationship between hospital and surgeon volume to rates of mortality and complications during the first 90 days after THA [4, 10]. The California Patient Discharge Database similarly contains data on mortality and complications. The database has the advantage of capturing complication rates of patients in the population of a state comparable in size to those covered in international registries. In addition, the age range is not limited by Medicare coverage. In the absence of a domestic joint replacement registry, the database provides a large alternative source of information on the rates and predictors of complication rates in a large group of patients from the United Stated including all age groups.

To confirm reported risk factors noted in the literature, we therefore identified patient and provider factors predicting complications after THA using the California database.

Patients and Methods

We obtained data for all hospitalizations in California during the years 1995 through 2005 from California's Office of Statewide Health Planning and Development (OSHPD). The OSHPD database is compiled annually and includes discharge abstracts from all licensed nonfederal hospitals in California [11, 12]. Each discharge abstract reports demographic information that includes age, gender, insurance type, and the race or ethnicity of the patient. In addition, International Classification of Diseases, 9th Revision (ICD-9) codes are entered into the record for each patient; the number of codes entered is not prespecified and the maximum allowed is up to 20 inpatient procedures and 24 diagnoses per hospitalization (Table 1). Hospital characteristics are also reported, including the teaching status and whether a hospital is classified as rural in location. The OSHPD state inpatient database was initiated as a component of the Healthcare Cost and Utilization Project (HCUP) and is collected through mandatory reporting by all nonfederal hospitals in the state of California. Institutional Review Board approval was obtained for this study.

We identified 138,399 patients undergoing their first THA using the ICD-9 procedure code for primary THA (81.51) who met inclusion and exclusion criteria. A previously published coding algorithm was modified and used to exclude 20,291 patients with infection, pathologic fracture, or undergoing revision arthroplasty [4, 10] (Appendix 1). We also excluded 3,848 patients with a non-California zip code to decrease the probability of the patient having

Table 1. Demographics of patient sample

Characteristic	Description of sample
Number of patients	138,399
Mean age (standard deviation)	66 years (+/− 13 yrs.)
Gender	
1) Male	1) 79,514 (57%)
2) Female	2) 58,885 (43%)
Race/Ethnicity	
1) White	1) 117,107 (85%)
2) Black	2) 6,051 (4%)
3) Hispanic	3) 9,368 (7%)
4) Asian/Pacific Islander	4) 3,006 (2%)
5) Other	5) 2,867 (2%)
Income < 20th percentile	5,840 (4%)
Complicated diabetes	743 (< 1%)
Peripheral vascular disease	2,179 (2%)
Rheumatoid arthritis	5,565 (4%)
Hospital volume	
1) High	1) 27,480 (20%)
2) Intermediate	2) 56,431 (41%)
3) Low	3) 54,488 (39%)
Teaching status	18,455 (13%)
Rural location	3,128 (2%)

prior admissions meeting exclusion criteria or experiencing a subsequent complication treated outside of the state. The unit of analysis was hospital discharge for each patient. All patients had basic demographic data as mandated by the state reporting requirements so no patients were excluded for missing data. Baseline patient characteristics were recorded in the database and analyzed. The mean age of the patient sample was 66 years with 85% being white. The population was diverse with 4% being black, 7% Hispanic, and 2% Asian. Complicated diabetes is defined as diabetes associated with end-organ damage; uncomplicated diabetes was noted in 8%, whereas less than 1% of patients had complicated diabetes. A diagnosis of rheumatoid arthritis was noted in 4% of patients (Table 1).

We selected the primary patient-based predictors: the Charlson comorbidity index [1, 9], age, race, gender, and income using zip code as a proxy as reported in the OSHPD database crossreferenced to US Census data. The Charlson comorbidity index assesses 19 comorbid conditions and has been validated for use in administrative database studies [1, 9]. This study uses the approach of Deyo et al. that adapted the Charlson index by defining the 19 comorbid conditions using ICD-9-CM coding and subsequently determining if the relevant codes are included in a patient record [1, 9]. In addition to the Charlson score, individual comorbidities were included for separate analysis consisting of diabetes, peripheral vascular disease, and rheumatoid arthritis.

Hospitals characteristics included surgical volume of THA, rural location, and teaching status. Teaching status and rural location are self-reported by the participating hospitals. Surgical volume was defined as the average number of primary THAs performed yearly during the study period. Hospitals were classified by their annual average volume as high-, intermediate-, or low-volume hospitals. Hospitals were categorized as low-volume if they were in the lowest 40th percentile by annual volume among hospitals where THA was performed. Intermediate-volume hospitals were defined as the next 40th percentile; high-volume hospitals were defined as the highest 20th percentile.

The outcomes analyzed as the dependent variables were the aggregate rate of short-term complications as well as the separately analyzed rates of individual complications, including mortality or readmission for the specific complications of infection, dislocation, revision surgery, perioperative fracture, neurologic injury, and thromboembolic disease at 90 days postoperatively. Previously published algorithms [4, 5] were adapted to detect codes consistent with a complication. The coding algorithms use ICD-9 nomenclature to identify patients undergoing total hip replacement using the 81.51 procedure code. Additional associated diagnoses, exclusion criteria, and complications are defined based on ICD-9 procedure and diagnoses codes judged by the authors to be consistent with the diagnoses or complications of interest. These algorithms were modified to correct for coding changes made during the study period [7, 11] (Appendix 1). Mortality was identified by the linkage of the California State Death Statistical Master File to the OSHPD database. This allowed us to identify hospital deaths occurring after discharge and the time elapsed before death in patients undergoing primary THA. The DSMF is a database of death certificates for all individuals dying in California and of those California residents who die outside of California's borders but within the United States [13].

We used multiple variable logistic regression models to determine the role of the patient and provider characteristics as independent variables in predicting the occurrence of the complications selected as dependent variables. This method allows us to report the odds ratio for each patient and provider independent variable adjusted for all of the other variables included in the model. The regression models included the patient characteristics of race/ethnicity, age, gender, income, specific comorbidities, and modified Charlson comorbidity index and the provider characteristics of hospital volume, rural location, and teaching status as independent variables. The strength of association between the risk of a complication and the patient and provider characteristics is reported as the odds ratio in relation to a reference group adjusted for all the other variables included in the model. P-values and 95% confidence intervals are reported with the odds ratios. All statistical analyses were conducted using Stata/SE 8.0 (Stata Corp, College Station, TX).

Results

Overall, the 90-day complication rate after primary THA was 3.8%. The most common complication identified was dislocation (1.4%). The mortality rate was 0.68%. The rates of infection, thromboembolic disease (including pulmonary embolism and deep venous thrombosis), neurovascular injury, perioperative fracture, and revision surgery were each below 1% (Table 2).

Increased age was associated with a higher risk of a short-term complication as was a higher Charlson comorbidity index (Table 3). One of the stronger predictors of an increased aggregate risk of a complication within 90 days was the presence of complicated diabetes (odds ratio [OR], 1.94; 95% confidence interval [CI], 1.49–2.53; $p < 0.001$) as a result of increased risks of mortality and infection. Relative to white patients, black patients had an increased risk of complications (OR, 1.19; 95% CI, 1.05–1.35; $p = 0.007$), whereas Hispanic (OR, 0.75; 95% CI, 0.67–0.85; $p < 0.001$) and Asian patients (OR, 0.54; 95% CI, 0.42–0.69; $p < 0.001$) had a lower risk. Patients' quintile of income was not associated with the aggregate risk of a complication. Hospital volume was the strongest predictor of a complication with both low-volume (OR, 2.00; 95% CI, 1.82–2.20; $p < 0.001$) and intermediate-volume (OR, 1.33; 95% CI, 1.22–1.45; $p < 0.001$) hospitals having an increased OR in relation to high-volume hospitals (Table 3). Teaching status and rural location were not associated with increased risks for most complications (Table 4).

Table 2. 90-day complication rates following total hip arthroplasty

Complication	Rate (# of cases)
Mortality	0.68% (943)
Dislocation	1.39% (1,930)
Infection	0.70% (969)
Thromboembolic disease	0.64% (883)
Perioperative fracture	0.01% (14)
Revision surgery	0.93% (1,289)
Neurovascular Injury	0.05% (74)
Overall rate of any complication within 90-days	3.81% (5,277)

Table 3. Odds ratios for a complication within 90-days according to patient and hospital characteristics

Patient or hospital characteristic	Reference group	90-day overall complication risk (Odds ratio, 95% confidence interval, p-value)
Patient characteristic		
Age > 75	Age > 65–75	**1.39 (1.30–1.48, p < 0.001)**
Age > 55–65	Age > 65–75	**0.89 (0.83–0.96, p = 0.005)**
Age ≤ 55	Age > 65–75	**0.72 (0.65–0.81, p < 0.001)**
Male gender	Female Gender	**1.10 (1.03–1.17, p = 0.02)**
Black race	White Race	**1.19 (1.05–1.35, p = 0.007)**
Hispanic ethnicity	White Race	**0.75 (0.67–0.85, p < 0.001)**
Asian race	White Race	**0.54 (0.42–0.69, p < 0.001)**
Income < 80th percentile	Income ≥ 20th percentile	1.11 (0.97–1.27, p = 0.12)
Patient comorbidity		
Charlson co-morbidity	Continuous variable	**1.21 (1.18–1.24, p < 0.001)**
Uncomplicated diabetes	Patients without diabetes	**1.31 (1.19–1.44, p < 0.001)**
Complicated diabetes	Patients without diabetes	**1.94 (1.49–2.53, p < 0.001)**
Peripheral vascular disease	Patients without PVD	**1.66 (1.30–2.11, p < 0.001)**
Rheumatoid disease	No rheumatoid disease	**1.53 (1.23–1.91, p < 0.001)**
Hospital characteristics		
Low-volume hospitals	High-volume hospitals	**2.00 (1.82–2.20, p < 0.001)**
Intermediate volume hospitals	High-volume hospitals	**1.33 (1.22–1.45, p < 0.001)**
Teaching status	Non-teaching status	1.05 (0.96–1.15, p = 0.30)
Rural location	Non-rural location	1.16 (0.97–1.38, p = 0.11)

$p < 0.05$ are given in bold.

Discussion

Many reports from various registries and individual papers report risk factors predicting complication rates after total hip arthroplasty (THA). However, the findings vary and there remains uncertainty regarding the relative importance of patient factors such as comorbidity and provider factors such as hospital volume in predicting complications. The California Office of Statewide Health Planning and Development (OSHPD) database provides a large alternate source of information. To confirm information in the literature, we therefore identified patient and provider factors predicting complications after THA using this alternate database. We specifically report the role of a variety of patient and hospital characteristics in predicting rates of mortality, infection, revision, dislocation, and thromboembolic disease after THA.

There are several limitations of studies examining administrative databases. First, this study was performed using a database of all patients in California over an 11-year period; this population may be less prone to selection bias than those studies looking at isolated Medicare populations. However, one potential bias in this population stems from patients having had surgery in California and sustaining a complication elsewhere, which would go unrecorded. More research is needed to determine if there is substantial bias in groups moving or receiving care outside of California. Another potential source of bias comes from relying on administrative registries. There can be substantial discrepancies between administrative data and audited and validated clinical data [10]. Second, the use of readmission and death records may underestimate morbidity and mortality if complications are not coded properly or do not require hospitalization. Third, the OSHPD statewide database does not include information on long-term functional outcomes. As a result, we could not evaluate the relationship of the predictor variables to functional outcome. Fourth, we were limited in our ability to identify confounding variables such as surgeon volume and training. Information on surgeon volume was not available and could not be evaluated separately from hospital volume. The studies by Katz et al. suggest both surgeon volume and hospital volume are independently associated with complication rates after THA [4]. Fifth, the California database includes hospital identifier but not surgeon identifiers, so we could not identify information on the relative importance of hospital and surgeon volume. Despite these limitations, the California discharge database has the advantage of being mandated by the state to include all admissions [13]. In addition, California is a large state with a diverse population allowing for the analysis of large numbers of patients from a variety of socioeconomic categories. In the absence of a formal domestic registry, the complication rates reported in this study provide an initial

Table 4. Odds ratios for specific complications at 90-days according to patient and hospital characteristics

Patient or hospital characteristic	Reference group	90-day mortality risk (Odds ratio, 95% confidence interval, p-value)	90-day infection risk (Odds ratio, 95% confidence interval, p-value)	90-day dislocation risk (Odds ratio, 95% confidence interval, p-value)	90-day revision risk (odds ratio, 95% confidence interval, p-value)	90-day thromboembolism risk (odds ratio, 95% confidence interval, p-value)
Patient characteristic						
Age > 75	Age > 65–75	**2.60 (2.22–3.04, p < 0.001)**	**1.28 (1.09–1.51, p = .003)**	**1.25 (1.12–1.40, p < 0.001)**	1.12 (0.96–1.31, p = 0.16)	1.12 (0.96–1.31, p = 0.16)
Age > 55–65	Age > 65–75	**0.61 (0.49–0.76, p < 0.001)**	1.10 (0.93–1.31, p = 0.26)	0.91 (0.81–1.03, p = 0.14)	**0.72 (0.60–0.87, p < 0.001)**	**0.72 (0.60–0.87, p < 0.001)**
Age ≤ 55	Age > 65–75	**0.26 (0.17–0.38, p < 0.001**	**1.34 (1.05–1.72, p = 0.02)**	**0.69 (0.58–0.83, p < 0.001)**	**0.42 (0.30–0.57, p < 0.001)**	**0.42 (0.30–0.57, p < 0.001)**
Male gender	Female gender	**1.23 (1.08–1.41, p = 0.002)**	1.14 (0.99–1.30, p = 0.06)	**1.16 (1.06–1.28, p = 0.001)**	1.06 (0.93–1.22, p = 0.37)	1.06 (0.93–1.22, p = 0.37)
Black race	White race	1.21 (0.89–1.66, p = 0.23)	**1.34 (10.5–1.73, p = 0.02)**	0.98 (0.79–1.21, p = 0.83)	**1.89 (1.44–2.47, p < 0.001)**	**1.89 (1.44–2.47, p < 0.001)**
Hispanic ethnicity	White race	0.84 (0.62–1.13, p = 0.25)	0.95 (0.74–1.21, p = 0.67)	**0.67 (0.55–0.83, p < 0.001)**	0.73 (0.53–1.01, p = 0.06)	0.73 (0.53–1.01, p = 0.61)
Asian race	White race	1.27 (0.82–1.97, p = 0.29)	0.87 (0.55–1.36, p = 0.54)	**0.41 (0.26–0.63, p < 0.001)**	**0.33 (0.15–0.73, p = 0.006)**	1.17 (0.75–1.83, p = 0.49)
Income < 80th percentile	Income ≥ 20th percentile	1.09 (0.79–1.51, p = 0.58)	**1.62 (1.26–2.09, p < 0.001)**	1.18, (0.96–1.32, p = 0.12)	**0.68 (0.46–0.99, p = 0.047)**	**0.68 (0.46–0.99, p = 0.047)**
Patient comorbidity						
Charlson co-morbidity	Continuous variable	**1.51 (1.45–1.58, p < 0.001)**	**1.22 (1.15–1.28, p < 0.001)**	**1.10 (1.05–1.15, p < 0.001)**	**1.11 (1.04–1.19, p = 0.003)**	**1.11 (1.04–1.19, p = 0.003)**
Uncomplicated diabetes	Patients without diabetes	**1.45 (1.18–1.77, p < 0.001)**	**1.72 (1.42–2.08, p < 0.001)**	**1.45 (1.25–1.67, p < 0.001)**	0.86 (0.67–1.11, p = 0.26)	0.86 (0.67–1.11, p = 0.26)
Complicated diabetes	Patients without diabetes	**2.65 (1.67–4.22, p < 0.001)**	**3.70 (2.39–5.74, p < 0.001)**	1.42 (0.86–2.34, p = 0.17)	1.04 (0.46–2.33, p = 0.93)	1.04 (0.46–2.33, p = 0.93)
Peripheral vascular disease	Patients without PVD	**2.00 (1.49–2.69, p < 0.001)**	1.31 (0.87–1.96, p = 0.20)	1.12 (0.81–1.53, p = 0.49)	1.10 (0.69–1.77, p = 0.69)	1.10 (0.69–1.77, p = 0.69)
Rheumatoid disease	No rheumatoid disease	**1.88 (1.17–3.03, p = 0.01)**	1.47 (0.90–2.41, p = 0.12)	1.50 (1.05–2.15, p = 0.26	1.46 (0.82–2.61, p = 0.20)	1.46 (0.82–2.61, p = 0.20)
Hospital characteristics						
Low-volume hospitals	High-volume hospitals	**1.82 (1.44–2.30, p < 0.001)**	**2.35 (1.87–2.94, p < 0.001)**	**2.43 (2.08–2.84, p < 0.001)**	**1.78 (1.42–2.22, p < 0.001)**	**1.78 (1.42–2.22, p < 0.001)**
Intermediate volume hospitals	High-volume hospitals	**1.45 (1.17–1.79, p = 0.001)**	**1.48 (1.20–1.83, p < 0.001)**	**1.40 (1.21–1.62, p < 0.001)**	1.22 (1.00–1.49, p = 0.05)	**1.22 (1.00–1.49, p = 0.046)**
Teaching status	Non-teaching status	0.93 (0.74–1.17 p = 0.53)	1.04 (0.85–1.28, p = 0.70)	1.15 (0.99–1.33, p = 0.06)	1.11 (0.90–1.36, p = 0.34)	1.11 (0.90–1.36, p = 0.34)
Rural location	Non-rural location	0.97 (0.66–1.43, p = 0;88)	1.42 (0.96–2.08, p = 0.08)	0.90 (0.66–1.23, p = 0.52)	**1.77 (1.22–2.57, p = 0.003)**	**1.77 (1.22–2.57, p = 0.003)**

$p < 0.05$ are given in bold.

Table 5. Short-term complication rates compared to Swedish Registry and Medicare Database analyses

Complication	90-day mortality	90-day dislocation	90-day thromboembolic disease	90-day infection	30-day readmission rate	Overall rate of any complication within 90-days
Katz et al. [4]	1.00%	3.10%	0.90%	0.20%	Not reported	Not reported
Swedish Registry [3]	0.76%	Not reported	Not reported	Not reported	3.90%	Not reported
SooHoo et al. [current study]	0.68%	1.39%	0.64%	0.90%	Not reported	3.81%

estimate of complication rates using population-based data on a large group of patients in the United States of all groups.

The overall 90-day complication rate of 0.68% for mortality, 0.64% for pulmonary embolus, and 1.39% for hip dislocation was lower than previously reported rates in the Medicare population of 1.0%, 0.9%, and 3.1%, respectively [6]. The Swedish Registry reported a similar 90-day mortality rate of 0.76% while the readmission rate was 3.9% within 30 days [3] (Table 5). The Australian and Finnish registries annual reports do not detail complication rates over periods shorter than 1-year so direct comparison to our study is not available [2, 8]. The higher rates of complication in Medicare analyses may demonstrate the selection bias in the Medicare population toward older and potentially sicker patients. Interestingly, our population had a higher wound infection rate of 0.9% than that previously reported in the Medicare population of 0.2% [6]. Further research is needed to elucidate the potential causes for this with respect to potential differences in the prevalence of diabetes, nosocomial infections, regional variations in pathogens, or intrinsic differences in our California population. Our dislocation rate of 1.39% was similar to previously published data in the Medicare population for those treated by surgeons who performed more than 50 THAs per year, 1.5%; however, this is notably different from the dislocation rate in those treated by surgeons who performed five or fewer per year, which has been reported as 4.2% [6]. Our study demonstrated similar increased risks of dislocation at lower-volume hospitals after adjusting for patient and provider characteristics. These observations may be useful for targeting interventions with a goal to decrease dislocation and complication rates at lower-volume centers.

Age, comorbidity, and race/ethnicity had an effect on the risk of short-term complications similar in magnitude to that of hospital volume. These findings are similar to those reported by Katz et al. who found age, gender, comorbidity, race, and income were associated with a higher risk of complications in the Medicare population [4]. Confirmation of these observations suggests the need for further study on the relative importance and underlying causes of these differences among populations. Future studies of these predictive factors would benefit from enriched data sources that include functional outcomes. Identifying these differing risks may be useful in counseling patients regarding the risks of surgery. The causes of these differences between populations warrant additional study to determine if they should play a role in patient selection or result in different approaches to perioperative care in patients at increased risk of complications.

This study reports short-term complication rates following total hip arthroplasty and the role of some patient and provider factors in predicting the occurrence of complications. The elucidation of these factors is useful in patient education and discussion of the perioperative risks of THA in different patient population.

Appendix 1

Inclusion Diagnosis codes – to be flagged

715	degenerative disease
7150	degenerative disease
71500	degenerative disease
71509	degenerative disease
7151	degenerative disease
71510	degenerative disease
71515	degenerative disease
7152	degenerative disease
71520	degenerative disease
71525	degenerative disease
7153	degenerative disease
71530	degenerative disease
71535	degenerative disease
718	degenerative disease
71580	degenerative disease
71585	degenerative disease
71589	degenerative disease
7159	degenerative disease
71590	degenerative disease
71595	degenerative disease

714 rheumatoid arthritis, JRA, and RA with systemic involvement
7140 rheumatoid arthritis, JRA, and RA with systemic involvement
7143 rheumatoid arthritis, JRA, and RA with systemic involvement
71430 rheumatoid arthritis, JRA, and RA with systemic involvement
71431 rheumatoid arthritis, JRA, and RA with systemic involvement
71432 rheumatoid arthritis, JRA, and RA with systemic involvement
71433 rheumatoid arthritis, JRA, and RA with systemic involvement

7334 AVN
73340 AVN
73342 AVN

7310 Pagets

73300 osteoporosis
73301 osteoporosis
73302 osteoporosis
73303 osteoporosis
73309 osteoporosis

27800 obesity - NOS
27801 obesity - morbid
27802 obesity - overweight
V850 obesity - BMI<19
V851 obesity - BMI 19-24
V8521 obesity - BMI 25-30
V8522 obesity - BMI 25-30
V8523 obesity - BMI 25-30
V8524 obesity - BMI 25-30
V8525 obesity - BMI 25-30
V8530 obesity - BMI 30-40
V8531 obesity - BMI 30-40
V8532 obesity - BMI 30-40
V8533 obesity - BMI 30-40
V8534 obesity - BMI 30-40
V8535 obesity - BMI 30-40
V8536 obesity - BMI 30-40
V8537 obesity - BMI 30-40
V8538 obesity - BMI 30-40
V8539 obesity - BMI 30-40
V854 obesity - BMI>40

Inclusion Procedure codes

8151 total hip replacement

Exclusion Codes –

Procedures

7905 fracture - femur
7915 fracture - femur
7925 fracture - femur
7935 fracture - femur

8153 revision hip replacement

786 removal of implanted device
7860 removal of implanted device
7865 removal of implanted device
800 arthrotomy for removal of prosthesis
8000 arthrotomy for removal of prosthesis
8005 arthrotomy for removal of prosthesis
8153

Diagnosis

820 fracture of neck, shaft, or unspecified - femur
8200 fracture of neck, shaft, or unspecified - femur
8200 fracture of neck, shaft, or unspecified - femur
82001 fracture of neck, shaft, or unspecified - femur
82001 fracture of neck, shaft, or unspecified - femur
82003 fracture of neck, shaft, or unspecified - femur
82009 fracture of neck, shaft, or unspecified - femur
8201 fracture of neck, shaft, or unspecified - femur
82010 fracture of neck, shaft, or unspecified - femur
82011 fracture of neck, shaft, or unspecified - femur
82012 fracture of neck, shaft, or unspecified - femur
82013 fracture of neck, shaft, or unspecified - femur
82019 fracture of neck, shaft, or unspecified - femur
8202 fracture of neck, shaft, or unspecified - femur
82020 fracture of neck, shaft, or unspecified - femur
82021 fracture of neck, shaft, or unspecified - femur
82022 fracture of neck, shaft, or unspecified - femur
8203 fracture of neck, shaft, or unspecified - femur
82030 fracture of neck, shaft, or unspecified - femur
82031 fracture of neck, shaft, or unspecified - femur
82032 fracture of neck, shaft, or unspecified - femur
8208 fracture of neck, shaft, or unspecified - femur
8209 fracture of neck, shaft, or unspecified - femur
821 fracture of neck, shaft, or unspecified - femur
8210 fracture of neck, shaft, or unspecified - femur
82100 fracture of neck, shaft, or unspecified - femur
82101 fracture of neck, shaft, or unspecified - femur
8211 fracture of neck, shaft, or unspecified - femur
82110 fracture of neck, shaft, or unspecified - femur
82111 fracture of neck, shaft, or unspecified - femur

8080	acetabulum, closed
8081	acetabulum, open
8082	pubis, closed
8083	pubis, open
80841	ilium, closed
80842	ischium, closed
80843	multiple pelvic, closed
80849	pelvic, other
80851	ilium, open
80852	ischium, open
80853	multiple pelvic, open
80850	other pelvic, open
8088	unspecified, pelvic, closed
71105	infection - hip
71165	infection - hip
71195	infection - hip
7300	infection - hip
73000	infection - hip
73005	infection - hip
7301	infection - hip
73010	infection - hip
73015	infection - hip
7302	infection - hip
73020	infection - hip
73025	infection - hip
7309	infection - hip
73090	infection - hip
73095	infection - hip
170	malignancy or pathoalogic fracture
1706	malignancy or pathoalogic fracture
1707	malignancy or pathoalogic fracture
1709	malignancy or pathoalogic fracture
1953	malignancy or pathoalogic fracture
1955	malignancy or pathoalogic fracture
198	malignancy or pathoalogic fracture
1985	malignancy or pathoalogic fracture
1990	malignancy or pathoalogic fracture
7331	malignancy or pathoalogic fracture
73314	malignancy or pathoalogic fracture
V540	aftercare for removal of fracture plate or other fixation device
9964	complications of implant
9966	complications of implant
99660	complications of implant
99666	complications of implant
99667	complications of implant
9967	complications of implant
99670	complications of implant
99677	complications of implant
99678	complications of implant

Outcome diagnosis of Interest

* Code descriptions ending in an * also require a V-code (to specify the joint)

41511	DVT/PE - iatrogenic pulmonary embolism and infarction
41519	DVT/PE - pulmonary embolism and infarction, other
45340	DVT/PE - deep venous thrombosis of lower extremity
45341	DVT/PE - DVT of proximal lower extremity
45342	DVT/PE - DVT of distal lower extremity
711	infection - arthropathy associated with infections
7110	infection - pyogenic arthritis
71100	infection - pyogenic arthritis, site unspecified
71105	infection - pyogenic arthritis, pelvic region and thigh
7116	infection - mycotic arthropathy
71160	infection - mycotic arthropathy, site unspecified
71165	infection - mycotic arthropathy, pelvic region and thigh
7119	infection - unspecified infective arthritis
71190	infection - unspecified infective arthritis, site unspecified
71195	infection - unspecified infective arthritis, pelvic region and thigh
7300	infection - acute osteomyelitis
73000	infection - acute osteomyelitis, site unspecified
73005	infection - acute osteomyelitis, pelvic region and thigh
7301	infection - chronic osteomyelitis
73010	infection - chronic osteomyelitis, site unspecified
73015	infection - chronic osteomyelitis, pelvic region and thigh
7302	infection - unspecified osteomyelitis
73020	infection - unspecified osteomyelitis, site unspecified
73025	infection - unspecified osteomyelitis, pelvic region and thigh
7309	infection - unspecified
73090	infection - unspecified unspecified site
73095	infection - unspecified infection of bone, pelvic region and thigh

99640 mechanical complication - unspecified mechanical complication of internal orthopedic device, implant, graft *
99641 mechanical complication - mechanical loosening of prosthetic joint *
99642 mechanical complication - dislocation of prosthetic joint *
99643 mechanical complication - prosthetic implant joint failure *
99644 mechanical complication - peri prosthetic fracture around prosthetic joint*
99645 mechanical complication - peri-prosthetic osteolysis *
99646 mechanical complication - articular bearing surface wear of prosthetic joint *
99647 mechanical complication - other mechanical complication of prosthetic joint implant *
99649 mechanical complication - other mechanical complication of other internal orthopedic device, implant, and graft *

99811 hemorrahge, hematoma, or seroma complicating a procedure
99812 hemorrahge, hematoma, or seroma complicating a procedure
99813 hemorrahge, hematoma, or seroma complicating a procedure

9982 neurovascular - accidental puncture or laceration during procedure on vessel, nerve, organ

9966 infection and inflammatory reaction due to joint prosthesis *

786 removal of implanted device from bone
7860 removal of implanted device from bone, site unspecified
7865 removal of implant device from bone, femur

800 arthrotomy for removal of prosthesis
8000 arthrotomy for removal of prosthesis, site unspecified
8005 arthrotomy for removal of prosthesis, hip

801 arthrotomy, other
8010 arthrotomy, other, site unspecified
8015 arthrotomy, other, hip

7975 closed reduction, hip
7985 open reduction, hip

8153 revision arthroplasty - Revision of hip replacement

8622 I and D - excisional debridement of wound, infection, burn
8628 I and D - nonexcisional debridement of wound, infection, burn
7765 I and D - local excision of lesion or tissue of bone, femur

Valid V codes – only used for outcomes with a *

V4364 v - hip

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