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Shoulder Arthroplasty versus Hip and Knee Arthroplasties

A Comparison of Outcomes

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Although outcomes of shoulder, hip, and knee arthroplasties have been well-described, there have been no studies directly comparing the outcomes of these procedures as treatments for osteoarthritis. We compared the inpatient mortality, complications, length of stay, and total charges of patients who had shoulder arthroplasty for osteoarthritis with those of patients who had hip and knee arthroplasties for osteoarthritis. A review of the Maryland Health Services Cost Review Commission discharge database identified 994 shoulder arthroplasties, 15,414 hip arthroplasties, and 34,471 knee arthroplasties performed for osteoarthritis from 1994 to 2001. There were no in-hospital deaths after shoulder arthroplasty, whereas 27 (0.18%) and 54 (0.16%) deaths occurred after hip and knee arthroplasties, respectively. Compared with patients who had hip or knee arthroplasties, patients who had shoulder arthroplasties had, on average, a lower complication rate, a shorter length of stay, and fewer total charges. The latter had ½ as many in-hospital complications, were ⅙ as likely to have a length of stay 6 days or greater, and were ¹⁄₁₀ as likely to be charged more than $15,000. We believe shoulder arthroplasty is as safe as the more commonly performed major joint arthroplasties.

Level of Evidence: Level II-1, prognostic study. See the Guidelines for Authors for a complete description of levels of evidence.

Total knee arthroplasty (TKA) and total hip arthroplasty (THA) are regarded as safe and effective methods to treat end-stage arthritis that is unresponsive to nonoperative management. During the last 20 years, the demand for total joint arthroplasties has increased annually—a trend that is expected to continue.[13]

Total shoulder arthroplasties (TSA) are performed less commonly than THAs and TKAs, but the procedure has become increasingly popular among shoulder surgeons. Although more general orthopaedists are performing TSAs,[11,12] the procedure remains unfamiliar to the general public. Clinicians other than orthopaedic surgeons frequently have questions about the morbidity and mortality of a TSA when determining whether they should recommend an evaluation. Sometimes patients perceive a TSA as a more complicated procedure with outcomes inferior to those of the more common types of arthroplasties.[11] In contrast, the orthopaedic literature has been grouping shoulder, hip, and knee arthroplasties into a major joint arthroplasty group for analysis of complications.[18]

Comparisons among common effective surgical procedures allow patients and providers to understand the relative risks and benefits of the procedures when similar criteria are used. Comparisons between different orthopaedic procedures, and between orthopaedic and nonorthopaedic procedures, are well described in the literature. Boorman et al[1] found a similar postoperative self-assured health status between TSA, THA, and coronary bypass procedures. Outcomes for THAs and TKAs have been compared with outcomes for coronary artery bypass and quality of life scores.[2,22] Lyman et al[24] examined predictors of thromboembolic events after shoulder arthroplasty. Using a statewide database for a primary diagnosis of osteoarthritis (OA), rheumatoid arthritis (RA), osteonecrosis, fracture, and dislocation, they compared those findings with those of hip and knee arthroplasties. Although investigators have reported on the morbidity and mortality of knee, hip, and shoulder arthroplasties,[5,10,17,21,27–31,33,35,38,40,41] no study directly compares the relative safety and outcomes of these three types of arthroplasties as a treatment specifically for OA.

Although there have been no studies directly comparing these three types of arthroplasties in patients with OA, two studies have examined separately, using the same national database, knee and shoulder outcomes, excluding pathologic fractures. A comparison of these two studies reveals

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that patients who had TSAs had similar postoperative complication rates, shorter length of stay, and similar mortality rates compared with patients who had TKAs.[14,17] Lyman et al[24] examined a state hospital database, including all principal diagnoses, and reported that the mortality rate of patients having TSAs was less than the rate of patients having THAs but similar to that of patients having TKAs. They also reported a shorter mean length of stay after a TSA than after hip and knee arthroplasties.[24]

Our primary research objective was to compare the in-hospital mortality, complications, total charges, and length of stay after TSA for treatment of OA with that after THA and TKA for treatment of OA. Based on the limited data available in the literature, and our personal experience, we hypothesized that these outcomes would be similar or lower for patients having TSAs than for THAs or TKAs.

MATERIALS AND METHODS

We performed a retrospective cohort study based on information on exposure variables and outcomes variables obtained from Maryland's Health Services Cost Review Commission discharge database from 1994 to 2001. This hospital database is a compilation of all patients in Maryland, regardless of payer status, who are admitted and discharged from a hospital; it contains discharges from 60 hospitals and more than 500 surgeons.[4,12,36,37] We used this database to determine the in-hospital mortality, complications, total charges, and length of stay for patients who had TSAs, THAs, or TKAs. The outcomes for TSA then were compared with those of THA and TKA to evaluate for any differences among the groups.

We selected only patients treated for OA based on the primary International Classification of Diseases (9th Revision, ICD-9) diagnosis codes (Appendix 1) for THA, bipolar hip arthroplasty, TKA, TSA, and shoulder hemiarthroplasty (ICD-9 procedure codes 81.51, 81.52, 81.54, 81.80, and 81.81, respectively).[26] Hip arthroplasty refers to bipolar and THA, and shoulder arthroplasty refers to TSA and hemiarthroplasty. Even though most bipolar hemiarthroplasties of the hip are performed for fractures, a small percentage was performed for OA, and therefore was included. Exclusion criteria included avascular necrosis, fractures, RA, and revision surgery.

After selecting the patient groups, we reviewed the discharge data to determine patient demographics (gender, age, race, and insurance type), hospital charges, length of stay, in-hospital complications, and in-hospital mortality. All patient and surgeon identifiers were masked.

From 1994 to 2001, 15,414 hip (15,308 THAs and 106 bipolar hip arthroplasties), 34,471 knee, and 994 shoulder arthroplasties (625 TSAs and 369 hemiarthroplasties) were performed in Maryland for OA. The average age of the 18,867 (37.1%) male and 32,012 (62.9%) female patients was 67.7 years (range, 12–107 years). Most were Caucasian (43,112 of 50,879; 84.7%) and married (30,913 of 50,879; 60.8%) (Table 1). Compared with the THA or TKA groups, the TSA group was older ($p < 0.01$) (average age, 69.2 years; range, 24–94 years), had a higher ($p < 0.01$) percentage of Caucasians (92.1%), and had a lower ($p < 0.05$) percentage of patients using Medicaid insurance (0.7%). The TKA group had a higher ($p < 0.01$) percentage of female patients than the TSA group and a higher ($p < 0.01$) percentage of patients with one or more comorbidities (Table 1).

We used secondary ICD-9 diagnosis codes[12] to identify complications. Complications were defined as those specified as a surgical complication, surgical mishap, or infection (Appendix 2). To diminish the effect of coding inaccuracies subject to wide interpretation, we made no attempt to evaluate ambiguous events that the database does not define as a preoperative or postoperative condition, unless it was coded explicitly as a postoperative complication. Mortality was considered an independent variable separate from complications.

The Charlson Comorbidity Index, adapted for ICD-9-CM administrative databases, was used to calculate a comorbidity score based on secondary ICD-9 codes.[3,6,32] This index gives a weighted score to a patient based on the number and seriousness of the comorbidities.[3] This score is calculated using the ICD-9-CM codes reported for the hospital stay at the time of discharge. All clinical outcomes were represented as dichotomous data based on these previously reported parameters: length of stay, less than 6 days versus 6 days or greater; total charges, of $15,000 or greater versus less than $15,000; complications, greater than 0 versus 0; and death.[12] Other parameters (length of

TABLE 1. Patient Demographics

Parameter	Total Group	Shoulder Arthroplasty	Hip Arthroplasty	Knee Arthroplasty
Number of patients	50,879	994*	15,414†	34,471
Average age (years)	67.7	69.2	66.5‡	68.1‡
Male (percent)	37.1	42.0	41.5	35‡
Caucasian (percent)	84.7	92.1	86.6‡	83.7‡
Married (percent)	60.8	60.3	60.7	60.8
Medicaid insurance (percent)	1.74	0.7	1.60§	1.84‡
Comorbidity index > 0 (percent)	31.4	29	28	33‡

*Included 625 patients who had TSAs and 369 who had hemiarthroplasties; †Included 15,308 patients who had THAs and 106 patients who had bipolar hip arthroplasties; ‡$p \leq 0.05$ compared with shoulder arthroplasty group; §$p \leq 0.01$ compared with shoulder arthroplasty group stay ≥ 2 days, 3 days, 4 days, and 5 days) were analyzed to determine if they were better end points to use, but no changes in statistics were noted. Therefore, we used the parameters established in a previous study.[12]

We compared baseline characteristics by analysis of variance (ANOVA) for the continuous variables and by the chi square analysis for categorical variables. Univariate and multivariate analyses were conducted with logistic regression to determine odds ratios for in-hospital complications, mortality, length of stay, and total charges for shoulder, hip, and knee arthroplasties. Multivariate analysis included the following covariates: age, gender, race, marital status, insurance type, and comorbidity via the Charlson Comorbidity Index. Covariates were included in the final multivariate model if they made a significant contribution based on the likelihood ratio test. Significance was set at $p \leq 0.05$, or an odds ratio ≠ 1. A power analysis was done to determine the confidence in concluding any nondifferences found between shoulders when compared with hips and knees. Data analysis was done with Stata Statistical Software: Release 8.0 (Stata Corp. 2001, College Station, TX).

RESULTS

There were no significant differences in mortality in the TSA group compared with the THA and TKA groups. In the THA group, there were 27 deaths after 15,414 procedures (0.18%). In the TKA group, there 54 deaths after 34,471 procedures (0.16%). There were no deaths among the 994 patients who had TSAs (Table 2). Although clinically important, these differences did not reach significance. A power analysis showed a power of 87% to detect a difference in mortality between shoulders and hips, and a power of 82% to detect a difference in mortality between shoulders and knees.

The patients who had TSAs had fewer ($p < 0.05$) postoperative complications than patients who had THAs and TKAs (Table 2). The percentage of patients having at least one in-hospital complication was 15.5% (2393 of 15,414) and 14.7% (5055 of 34,471) for THA and TKA, respectively, compared with 7.55% (75 of 994) for TSA (Table 2). Univariate analysis revealed that patients who had TSAs for OA were ½ as likely to have at least one in-hospital complication (odds ratio [OR], 0.46; 95% CI, 0.37–0.59) than patients who had THAs or TKAs for OA (Table 3).

Patients who had TSAs had lower total hospital charges than those who had THAs or TKAs (Table 2). The average total charges were $15,442 (range, $1241–$271,479) and $14,674 (range, $1054–$222,071) for THA and TKA, respectively, compared with an average charge of $10,351 (range, $1304–$106,054) for TSA (Table 2). Univariate analysis showed that patients who had TSAs were 1⁄10 as likely as those who had THAs or TKAs to have a total charge greater than $15,000 (OR, 0.11; 95% CI, 0.08–0.14) (Table 3).

The average length of stay was shorter for patients who had TSAs than for patients who had THAs or TKAs (Table 2): 2.42 days (range, 1–51 days), 4.37 days (range, 0–129 days), and 4.31 days (range, 0–50 days), respectively (Table 2). Univariate analysis revealed that patients who had TSAs were ⅙ as those who had THAs or TKAs to have a length of stay of 6 days or greater (OR, 0.16; 95% CI, 0.11–0.22) (Table 3).

All of the univariate analysis differences were significant ($p < 0.05$) (Table 3) and were unaffected by controlling for age, gender, race, marital status, insurance type, and comorbidities (Table 4). Multivariate analysis showed that a higher incidence of complications was associated with having a THA or TKA, age older than 65 years, being male, being nonCaucasian, or having a Charlson Comorbidity Index greater than 0 ($p < 0.05$). Higher charges were associated with the following characteristics: having a THA or TKA, age younger than 65 years, being male, being nonCaucasian, being unmarried, having nonMedicaid insurance, or a having a Charlson Comorbidity Index greater than 0 ($p < 0.05$). A longer length of stay was associated with having a THA or TKA, age older than 65 years, being nonCaucasian, being unmarried, having non-Medicaid insurance, or having a Charlson Comorbidity Index greater than 0 ($p < 0.05$) (Table 4).

DISCUSSION

Our goal was to compare inpatient mortality, complications, total charges, and length of stay of patients who had TSAs versus patients who had THAs and TKAs because no previous study compared these procedures as treatment for OA. Although the decision to perform an arthroplasty

TABLE 2. Clinical and Economic Outcomes

Arthroplasty Group	Mortality Rate (percent)	Complication Rate (percent)	Mean Length of Stay (days)	Mean Hospital Charge (US dollars)
Hip	0.18	15.5	4.37	15,442
Knee	0.16	14.7	4.31	14,674
Shoulder	0	7.55	2.42	10,351

TABLE 3. Univariate Analysis of Outcomes*

	Outcome†		
Exposure	*Length of Stay*	*Total Charges*	*Risk of Complications*
Shoulder versus knee	0.16 (0.12–0.23)	0.12 (0.1–0.16)	0.48 (0.38–0.60)
Shoulder versus hip	0.15 (0.11–0.21)	0.08 (0.06–0.10)	0.44 (0.35–0.56)
Shoulder versus hip/knee	0.16 (0.12–0.22)	0.11 (0.08–0.14)	0.47 (0.37–0.59)

*Values given as odds ratios with 95% confidence intervals in parentheses; all values were significant at $p \leq 0.05$; †length of stay ≥ 6 days, total charges ≥ $15,000, and complications are defined as one or more; mortality differences were not significant at $p > 0.05$

is based on the individual patient, our data emphasize the relative safety of a TSA. By comparing the outcomes of TSA with those of THA and TKA, our results can help patients and physicians better understand the relative risks and outcomes of these procedures.

The use of large databases has inherent limitations that may have affected our results. Administrative data sets have been criticized for having high error rates in data collection.[7,9,15,16,19,20,25] The demographic information in data sets typically has been accurate, but the complications and comorbidities may be inaccurate because of coding by nonmedical personnel, variations in the definition of a complication, and the variability in the threshold for what is reportable.[25] To minimize the errors, a data vendor performs quarterly error checks on inpatient and outpatient data sets in the Health Services Cost Review Commission database. In Maryland, hospital reimbursement is based on complete reporting to the Health Services Cost Review Commission by the hospital, so there is incentive for accurate data reporting. For a hospital data set to be considered complete, error rates by a given hospital must be less than 10%.[12] An independent chart review showed this database had a positive predictive value of 82% and a negative predictive value of 98% for patients who had thyroidectomies.[37] Despite these limitations, this database has been used in numerous studies to examine these and similar outcomes for various surgical procedures.[4,12,36,37]

Another limitation of this study involves the coding of secondary diagnoses in the database. The ICD-9 coding of secondary diagnoses can be ambiguous as to whether the diagnosis occurred during the hospital stay or whether the diagnosis is part of the medical history. For instance, the ICD-9-CM code for congestive heart failure is 428.0. If this were coded as a secondary diagnosis, it is impossible to discern if this was a preoperative diagnosis, or occurred as a postoperative complication. It is possible that if this event occurred as a postoperative complication, it would be coded as 997.1, surgical complication-heart. Therefore, we restricted our list of complications to those that describe the event as a complication (Appendix 2). A postoperative pulmonary embolism would be included as a complication if it were coded as a surgical complication of the respiratory system. It is likely that a certain percentage of complications were not included in this analysis because of how they were coded at the time of discharge. We assume with this analysis that the percentages of nonincluded complications are similar among the three procedures studied, thus minimizing any effect on the outcome.

We identified no in-hospital mortalities after TSA. Jain et al[17] reported 32 inpatient deaths among 12,594 patients

TABLE 4. Multivariate Analysis of Outcomes*,†

	Outcomes‡		
Characteristic	*Length of Stay*	*Total Charges*	*Risk of Complications*
Shoulder versus hip/knee	0.16 (0.12–0.22)	0.11 (0.08–0.14)	0.46 (0.37–0.59)
Age > 65 versus < 65 years	1.46 (1.39–1.54)	0.84 (0.81–0.87)	1.20 (1.13–1.27)
Female versus male	NS	0.84 (0.8–0.87)	0.76 (0.73–0.80)
NonCaucasian versus Caucasian	1.14 (1.08–1.21)	1.55 (1.47–1.63)	1.27 (1.19–1.36)
Married versus unmarried	0.87 (0.83–0.91)	0.89 (0.86–0.93)	NS
Medicaid versus other insurance	0.62 (0.53–0.73)	0.81 (0.7–0.93)	NS
CCI > 0 versus CCI = 0	1.14 (1.08–1.22)	1.2 (1.48–1.63)	1.17 (1.11–1.24)

*Values are given as odds ratios with 95% confidence intervals in parentheses; all values that had a $p \leq 0.05$ were included in the final model; all values with a $p > 0.05$ were dropped from the final model; †All values were adjusted for other confounding variables (age, gender, race, marital status, insurance type, comorbidity, and shoulder arthroplasty) in the final model; ‡Length of stay ≥ 6 days; total charges ≥ $15,000; complications, ≥ 1 complication; mortality differences were not significant; NS = nonsignificant

(0.3%) nationwide after TSAs from 1988 to 2000. Their study included patients who had shoulder arthroplasties for various diagnoses, including OA, inflammatory arthritis, avascular necrosis, and fractures of the humerus, scapula, or glenoid. White et al[40] reported a 90-day mortality incidence of 0.58% after TSA performed for any cause. Most of the patients in their study who died had TSAs performed for tumors or fractures (12 of 17 deaths). In their study, no deaths occurred after elective TSA performed for primary OA. Lyman et al[24] noted a mortality rate of 0.24% after TSA for any indication.

We found no difference between the mortality rates of TSA, TKA, and THA in patients from this database, with a power greater than 80%. However, we believe our results are clinically important when discussing the risks and benefits of these procedures with patients or other healthcare providers. When patients with OA inquire about the risks of TSA, we inform them there were no deaths after TSAs during this 7-year period. Although our mortality rates are similar to those reported previously (Table 5),[5,10,17,21,27–31,33,35,38,40,41] they differ in that other studies used databases or cohorts with different demographics, insurance profiles, and other variables (such as diagnoses), which makes direct comparison difficult.

Our finding that patients who had TSAs had shorter lengths of stay than patients who had THAs or TKAs was similar to that of Lyman et al,[24] who noted a length of stay of 3.1 ± 2.7 days for TSAs, 5.1 ± 3.6 days for THAs, and 4.8 ± 2.9 days for TKAs. Previous studies have explored the relationship between length of stay and various risk factors in hip and knee arthroplasties. Epps[8] found length of stay increased with a greater number of postoperative complications after THA and TKA. Our data support those findings. The THA group had a similar complication percentage and mean length of stay as the TKA group. The patients who had TSAs had approximately ½ the compli-

TABLE 5. Comparison of Mortality Rates Reported for Hip, Knee, and Shoulder Arthroplasties

Study	Number of Patients	Diagnosis*	Population	Length of Postoperative Followup†	Mortality Rate (percent)
Total knee arthroplasty					
Morrey et al[27]	1253	1, 2, 3	Mayo Clinic database	≥ 2 years	4.95
Sharrock et al[35]	9685	1, 2	Hospital of Special Surgery database	≥ 8 days	0.1
Parvizi et al[30]	22,540	1, 2, 4, 5	Mayo Clinic database	30 days	0.21
Gill et al[10]	3048	1, 2	Covernan Medical Center database	90 days	0.46
Total hip arthroplasty					
Whittle et al[41]	5078	1, 2, 3, 4, 5	Medicare data set	30 days	0.95
Seagroatt and Goldacre[33]	9773	N/A	The Oxford record linkage study	1 year	3.8
Sharrock et al[35]	5874	1, 2, 5	Hospital of Special Surgery database	≥ 8 days	0.39
Dearborn and Harris[5]	2736	1, 2, 3, 4, 5	Massachusetts General Hospital database	90 days	0.3
Parvizi et al[29]	30,714	1, 2, 5	Mayo Clinic database	30 days	0.29
Total hip arthroplasty, total knee arthroplasty					
Peterson et al[31]	124,695	1, 2, 5	Medicare provider analysis and review files	N/A (length of stay = 11.7 ± 6.3 days)	0.58
Lavernia and Guzman[21]	22,461	N/A	Florida patient discharge information	9.8 days	0.95
Taylor et al[38]	632,319	N/A	Medicare provider analysis and review	30 days	2.3
Nunley and Lachiewicz[28]	1718	1, 2, 3, 4, 5	University of North Carolina at Chapel Hill database	2 years	0.4
Total shoulder arthroplasty					
White et al[40]	2953	1, 2, 3, 5	Mayo Clinic database	90 days	0.58
Jain et al[17]	30,042	1, 2, 3, 5	Nationwide Inpatient Sample database	4.9 ± 5.3 days	0.35
Lyman et al[24]	4931	1, 2, 3, 4, 5, 6	New York state discharge database	4.7 ± 5 days	0.24

*1 = osteoarthritis, 2 = rheumatoid arthritis, 3 = trauma, 4 = fracture (pathologic), 5 = avascular necrosis, 6 = other; †N/A = not available cation percentage and ½ the mean length of stay of patients who had hip or knee arthroplasty (Table 2), suggesting the two factors may be related.

Previous studies correlated a higher number of comorbidities with increased total charges after hip and knee arthroplasties.[34,39] This variable was included in our final model, but the number of comorbidities did not explain the differences noted in total charges. Lester and Linn[23] showed length of stay after total joint arthroplasty was the most important factor affecting total hospital charges. In our study, patients who had TSAs had a mean length of stay of 2.4 days, compared with 4.3 days for those who had THA or TKAs (Table 2). This difference likely accounts for much of the higher total charges seen in patients who had a hip or knee arthroplasty.

Patients who had TSAs had fewer complications, a shorter length of stay, and lower total charges than those who had a hip or knee arthroplasty. Shoulder arthroplasty performed for OA should be considered as safe as the more commonly performed hip and knee arthroplasties. This information is helpful to patients and clinicians who desire an understanding of the relative short-term risks of these procedures. In addition, the differences in outcomes are important when designing future studies that may group shoulder, hip, and knee arthroplasties into one major joint arthroplasty group for comparison with other orthopaedic or nonorthopaedic surgical procedures. A prospective study is needed to compare these three procedures in more detail and to evaluate outcomes after a longer followup.

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APPENDIX 1. Diagnoses and ICD-9 Diagnostic Codes

Osteoarthritis	ICD-9
Generalized—multiple sites	715.09
Localized—primary—shoulder	715.11
Localized—primary of upper arm	715.12
Localized—primary—pelvic region and thigh	715.15
Localized—primary—lower leg	715.16
Localized—secondary	715.21
Localized—secondary—upper arm	715.22
Localized—secondary pelvic region and thigh	715.25
Localized—secondary—lower leg	715.26
Localized—shoulder	715.31
Localized—upper arm	715.32
Localized—pelvic region and thigh	715.35
Localized—lower leg	715.36
> 1 site not generalized	715.89
Shoulder unspecified	715.91
Unspecified	715.92
Unspecified—pelvic region and thigh	715.95
Unspecified—lower leg	715.96

APPENDIX 2. Complications by ICD-9-CM Diagnosis Codes*

Diagnosis†	ICD-9-CM Code
Cardiovascular/hematologic	
Iatrogenic hypotension	458.2
Surgical complication—heart	997.1
Surgical complication—hypertension	997.91
Hemorrhage complication procedure	998.1
Peripheral vascular complications	997.2
Drug reaction	
Adverse effect nerve-block anesthesia	E938.6
Gastrointestinal	
Surgical complication—digestive system	997.4
Infection	
Infection due to prosthesis	996.66
Postoperative infection	998.5
Neurologic	
Surgical complication—nervous system NEC	997.09
Respiratory	
Surgical complication—respiratory system	997.3
Revision/failure	
Arthrotomy for removal of prosthesis—shoulder	80.01
Revision joint replacement—upper extremity	81.97
Revision joint replacement—hip	81.53
Revision joint replacement—knee	81.55
Arthrotomy for removal of prosthesis—shoulder—knee	80.06
Arthrotomy for removal of prosthesis—shoulder—hip	80.05
Surgical mishaps	
Mechanical complication of other vascular device/graft	996.1
Mechanical complication of internal orthopaedic device	996.4
Mechanical complication of implant NEC	996.59
Reaction due to other vascular device/graft	996.62
Reaction due to internal joint prosthesis	996.66
Other complications due to internal joint prosthesis	996.77
Complication due to orthopaedic device/implant	996.78
Complication due to other internal prosthetic device, implant and graft NEC	996.79
Iatrogenic congestive vascular accident; postoperative stroke	997.02
Surgical complication—body system NEC	997.9
Accidental operative laceration	998.2
Disruption of external operation wound NOS	998.32
Surgical complication NEC	998.8
Other specified complication	998.89
Surgical complication NOS	998.9
Unspecified complications of medical care NEC	999.9
Accidental cut during operation	E870.0
Misadventure specified type NEC	E876.8
Reaction—artificial prosthesis	E878.1
Reaction—implant for bypass or anastomosis	E878.2
Reaction—surgical procedure NEC	E878.8
Reaction—procedure NEC	E879.8
Urologic	
Surgical complication – urinary tract	997.5

*Modified with permission from Hammond JW, Queale WS, Kim TK, McFarland EG. Surgeon experience and clinical and economic outcomes for shoulder arthroplasty. *J Bone Joint Surg Am*. 2003;85:2318–2324.

†NOS = not otherwise specified; NEC = not elsewhere classified