Nationwide Trends in Total Shoulder Arthroplasty and Hemiarthroplasty for Osteoarthritis

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Abstract

Recent literature reports an increase in the rate of shoulder arthroplasties, particularly total shoulder arthroplasties (TSAs), being performed in the United States. However, the national epidemiology of use of hemiarthroplasty (HA) and TSA as treatments for glenohumeral osteoarthritis has not been elucidated.

We conducted a study to analyze trends in using HA and TSA as treatments for glenohumeral osteoarthritis from 2000 to 2010, and to compare patient characteristics and inpatient complications. US Nationwide Inpatient Sample patients with a primary inpatient diagnosis of shoulder arthritis and a principal procedure of HA or TSA were identified using *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD–9–CM)* procedural codes.

From 2000 to 2010 the nationally adjusted population rate of shoulder arthroplasty performed for osteoarthritis increased 3.7-fold. Specifically, the population rate of TSA increased 5.0-fold, and that of HA increased 1.9-fold. In 2010, 80.3% of patients having shoulder arthroplasty for arthritis underwent TSA. TSA patients were older ($P < .0001$) and had a higher mean number of chronic illnesses ($P = .034$). TSA-associated discharges had a higher rate of surgical and medical care complications ($P = .011$) and blood transfusions ($P = .041$) after adjusting for comorbidities.

Shoulder pain is a common problem affecting 5% to 21% of adults in the United States and can result in significant morbidity and disability, and increased health care costs.[1] Glenohumeral arthritis is one of many causes of shoulder pain. The indication for surgical correction of glenohumeral osteoarthritis is severe, chronic, and progressive pain that results in decreased range of motion and impaired function that has failed conservative management.[2-4] The options for surgical management of end-stage shoulder osteoarthritis include arthroscopic debridement, interpositional arthroplasty, cartilage repair, and shoulder arthroplasty, which may be in the form of total shoulder arthroplasty (TSA), hemiarthroplasty (HA), or reverse TSA (RTSA).[1] Lack of evidence-based efficacy for conservative and less invasive operative procedures has propelled arthroplasty to the forefront of glenohumeral osteoarthritis treatment. Advantages of HA include decreased operative time and blood loss, but risks include future glenoid osteoarthritic changes.[5] TSA requires adequate bone stock for glenoid resurfacing and a functional rotator cuff but is more technically challenging and carries the feared risk of glenoid loosening. Nevertheless, the most current literature supports TSA as the premier modality for treating osteoarthritis given the better improvements in pain, disability, function, range of motion, and lower revision rates versus HA.[1,5-7] This point is echoed in the 2009 American Academy of Orthopaedic Surgeons shoulder osteoarthritis guidelines, which give TSA a moderate-strength recommendation as the superior operative treatment for glenohumeral osteoarthritis.[8]

Recently, several investigators have examined the national epidemiologic trends in shoulder arthroplasty. Between 1990 and 2000, the volume of TSAs increased minimally[9]; however, the average annual population rates of TSA and HA increased by 10.6% and 6.7%, respectively, between 1993 and 2007.[10] HA was the more commonly performed procedure up until 2006, when it was surpassed by TSA.[11] In the same study, Kim and colleagues[11] found an increase in TSA procedures being performed, starting in 2004. This was attributed to the 2003 Food and Drug Administration (FDA) approval of RTSA, which has had, up until very recently, the same *International Classification of Diseases, Ninth Revision (ICD–9)* procedural code as TSA.

These epidemiologic studies compared TSA and HA for all indications. However, as osteoarthritis was the primary diagnosis code for 43% of HAs and 77% of TSAs in 2008, we wanted to analyze the most recent national trends in performing HA and TSA only for glenohumeral osteoarthritis.[11] In this article, we report the results of our study as well as information on the patient population that is receiving shoulder replacement

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for osteoarthritis, payer and hospital characteristics, and the associated complications of both procedures in 2010.

Materials and Methods

The Nationwide Inpatient Sample (NIS) is one of many databases created as part of the Healthcare Cost and Utilization Project, which is sponsored by the Agency for Healthcare Research and Quality (AHRQ). This database has been used to analyze trends in health care use and quality at the national level. The NIS is the only US all-payer inpatient database with discharges from patients in all age groups. As of 2010, there were more than 1051 hospitals in 45 states in the database, representing 20% of all US community hospitals. For this study, *ICD–9, Clinical Modification* (*ICD–9–CM*) diagnosis and procedure codes were used to identify discharges; also used was AHRQ's Clinical Classification Software (CCS), which combines relevant *ICD–9–CM* codes into clinically meaningful groups (www.hcup-us.ahrq.gov/toolssoftware/ccs/AppendixASingleDX.txt). For calculation of national estimates, discharge weights supplied by AHRQ were applied to the data. Population rates per 100,000 US people were calculated by dividing weighted discharges by the US Census yearly population estimate.[12]

The NIS was used to identify all discharges with a principal diagnosis of shoulder osteoarthritis (*ICD–9–CM* 715.11, 715.21, 715.31, 715.91). Subsequently, patients who underwent primary TSA (*ICD–9–CM* 81.80) or HA (*ICD–9–CM* 81.81) between 2000 and 2010 were identified. Exclusion criteria included acute fracture (CCS 229, 231) and pathologic fracture (CCS 207). The 2010 patient and hospital characteristics for HA and TSA were compared, as were the inpatient complication rates. The AHRQ comorbidity software modeled on the Elixhauser algorithm was used to identify comorbidities, except for smoking status, which was identified using *ICD–9–CM* 305.1, tobacco use disorder.[13] The complications investigated included complications of surgical procedures or medical care (CCS 238), inpatient mortality, blood transfusions, select cardiovascular events, and select infectious processes. The **Appendix** defines all *ICD–9–CM* diagnosis and procedure codes used in this study.

SAS version 9.1 (SAS, Cary, North Carolina) was used to perform the statistical analyses. Significance of changes over time was assessed using *z* tests, χ^2 tests, and *t* tests. Multivariate analyses of complications were performed by adjusting for age and comorbidities on univariate analysis. $P \leq .05$ was considered significant in all the analyses.

Results

National Trends in TSA and HA, 2000 to 2010

Between 2000 and 2010 in the United States, an

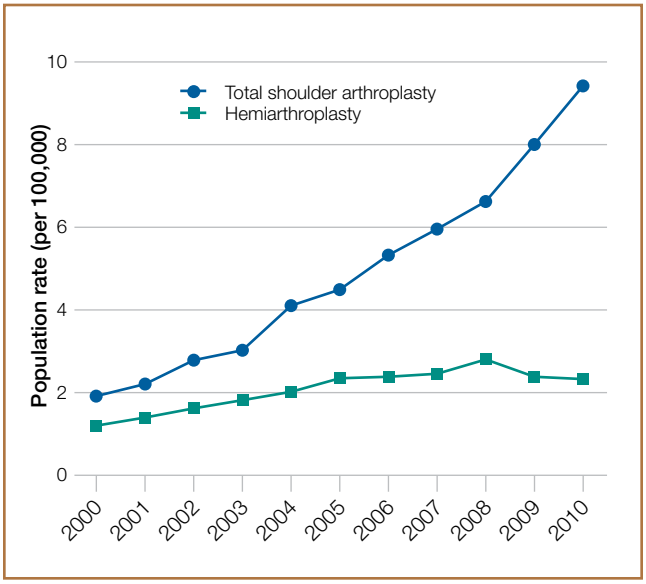

Figure. Line graph of national estimates of annual population rates for total shoulder arthroplasty and hemiarthroplasty, 2000 to 2010.

Table I. Patient Characteristics, 2010

	Hemiarthroplasty		Total Shoulder Arthroplasty		
Characteristic	**n**	**%**	**n**	**%**	***P***
Total	**7152**	**19.7%**	**29,197**	**80.3%**	
Population rate	**2.3/100,000**		**9.5/100,000**		**< .0001**
Mean (SD) age, y	**67.2**	**(11.9)**	**68.7**	**(9.5)**	**< .0001**
Age Groups, y					**< .0001**
≤ 17	0	0.0%	0	0.0%	
18-44	257	3.5%	306	1.0%	
45-64	2471	34.5%	8647	29.6%	
65+	4415	61.7%	20,193	69.2%	
Sex					**.072**
Male	3393	47.4%	13,522	46.3%	
Female	3730	52.6%	15,590	53.7%	
Race					**< .0001**
White	5607	78.4%	22,285	76.3%	
Black	321	4.5%	960	3.3%	
Hispanic	228	3.2%	641	2.2%	
Asian or Pacific Islander	29	0.4%	46	0.2%	
Native American	54	0.8%	120	0.4%	
Other	51	0.7%	521	1.8%	

estimated 228,790 inpatient discharges had a principal procedure code of TSA or HA associated with a primary diagnosis of shoulder osteoarthritis. The national rate per 100,000 people for using shoulder arthroplasty to treat osteoarthritis increased from 3.1 (8746 discharges) in 2000 to 11.8 (36,349 discharges) in 2010.

Over the study period, TSAs (161,597, 70.6%) outnumbered HAs (67,193, 29.4%), and more TSAs than HAs were performed in every year studied. From 2000 to 2010, the population rate of TSAs increased 5.0-fold, compared with a 1.9-fold increase in HAs (**Figure**). The population rate of TSAs performed for osteoarthritis increased each subsequent study year. The population rate of HAs performed for osteoarthritis increased from 2000 to 2008, but decreased in 2009 and again in 2010.

Table II. **Univariate Analyses of Patient Comorbidities for Total Shoulder Arthroplasty and Hemiarthroplasty Discharges, 2010**

	Hemiarthroplasty		Total Shoulder Arthroplasty		
Comorbidity	**n**	**%**	**n**	**%**	***P***
Mean (SD) no. of chronic illnesses	4.7	(2.5)	4.8	(2.4)	.034
Behavioral					
Smoking	1127	15.8%	5067	17.4%	.001
Alcohol abuse	48	0.7%	246	0.8%	.138
Drug abuse	30	0.4%	132	0.5%	.753
Cardiovascular					
Hypertension	4719	66.0%	19,707	67.5%	.014
Peripheral vascular disease	195	2.7%	628	2.2%	.003
Congestive heart failure	209	2.9%	794	2.7%	.352
Endocrine					
Diabetes mellitus, uncomplicated	1397	19.5%	5185	17.8%	.001
Diabetes mellitus, complicated	83	1.2%	490	1.7%	.001
Other					
Chronic lung disease	1141	15.6%	5174	17.7%	< .001
Liver disease	79	1.1%	303	1.0%	.605
Renal failure	243	3.4%	1123	3.9%	.075
Obesity	1062	14.8%	3973	13.6%	.007
Coagulopathy	71	1.0%	526	1.8%	< .0001
Depression	957	13.4%	3996	13.7%	.491

Patient Characteristics, 2010 (Table I)

In 2010, 7152 HAs (19.7%) and 29,197 TSAs (80.3%) were performed for osteoarthritis. Mean age of patients who had shoulder arthroplasty (HA, TSA) in 2010 was 68.4 years, and the majority of patients who had either HA (61.7%) or TSA (69.2%) were 65 or older. Mean age was lower for HA patients (67.2 years) than for TSA patients (68.7 years) ($P < .0001$). For patients who had either type of shoulder arthroplasty, women outnumbered men 1.4:1; however, there was no difference in sex distribution between HA and TSA ($P = .072$). The large majority of shoulder arthritis patients who had HA (78.4%) or TSA (76.3%) were white, and there was a difference in the distribution of races who received HA versus TSA ($P < .0001$).

Patient Comorbidities, 2010 (Table II)

TSA patients had a higher mean number of chronic illnesses (4.8 vs 4.7, $P = .034$). Several comorbidities were more commonly present in TSA discharges: smoking ($P = .001$), hypertension ($P = .014$), diabetes mellitus with complications ($P = .001$), chronic lung disease ($P < .001$), and coagulopathy ($P < .0001$). In contrast, obesity ($P < .0001$), peripheral vascular disease ($P = .003$), and diabetes without complications ($P = .001$) were more common in HA discharges.

Payer and Hospital Characteristics, 2010 (Table III)

There was no significant difference in mean length of hospital stay between patients who had TSA (2.1 days) or HA (2.0 days). Nevertheless, for osteoarthritis, TSA was on average $12,033 more expensive than HA ($P < .0001$). Medicare covered 65.3% of shoulder arthroplasty operations in the US in 2010. There was a significant difference in distribution of payers between the operations, though Medicare was the primary payer for both procedures, followed by private insurance ($P < .0001$). The procedure rate for TSA was higher in every US Census region (Northeast, South, Midwest, West) than for HA. Rates of TSAs and HAs were higher in the Midwest than in any other region.

Inpatient Complications, 2010 (Tables IV, V)

A univariate analysis comparing all inpatient complications associated with TSA and HA is presented in **Table IV**. The inpatient mortality rate for shoulder arthroplasty was extremely low, 0.0% for HA and 0.03% for TSA ($P = .111$). In an analysis of CCS category 238 (complications of surgical procedures or medical care), there was a higher rate of complications in TSA discharges (6.2%) than in HA discharges (4.1%) ($P < .0001$). Cardiovascular complications and acute infections were rare complications of

shoulder arthroplasty discharges. TSAs had an overall higher incidence of cardiovascular complications ($P < .0001$), including myocardial infarction ($P = .027$) and pulmonary embolism ($P = .001$). There were no HA–TSA differences in rates of infections, including bacterial infections of unspecified site, pneumonia, and urinary tract infections. The blood transfusion rate was higher in TSA discharges (4.7%) than in HA discharges (3.1%) ($P < .0001$).

In the multivariate analysis of all inpatient complications associated with TSA and HA in 2010, adjusting for age and significant comorbidities (**Table V**), complications of surgical procedures or medical care ($P = .011$) and blood transfusions ($P = .041$) occurred at a higher rate in TSA discharges than in HA discharges.

Discussion

To our knowledge, this is the most recent national comparison of shoulder HA and TSA epidemiology for the treatment of glenohumeral osteoarthritis. The national population rate of shoulder arthroplasties performed for osteoarthritis increased 3.7-fold over the decade studied. As predicted by Day and colleagues,[10] the population rate of shoulder arthroplasty increased at a higher rate compared to total hip arthroplasty (1.3-fold) and total knee arthroplasty (2.0-fold) during a similar timeframe.[14] Several factors may have contributed to the expanding number of shoulder arthroplasties performed for arthritis over the past decade—including an increasing elderly population, a growing number of shoulder arthroplasty component manufacturers (resulting in more commercial marketing), and a larger number of orthopedic surgeons specializing in shoulder surgery.[11]

In the present study, we found that TSA is largely responsible for the increased incidence of shoulder arthroplasties being performed for osteoarthritis. In fact, the incidence of TSA increased in every year studied in this investigation such that, in 2010, 80.3% of all shoulder arthroplasties involved glenoid resurfacing. On the other hand, the number of HAs performed for osteoarthritis decreased in 2009 and in 2010. These results suggest that, though choice of HA versus TSA has traditionally been one of surgeon preference, HA is losing favor, despite osteoarthritis being its most common indication.[11] Interestingly, this downward trend contradicts the prediction posed by Day and colleagues[10]—that the HA population rate will increase 192% from 2007 to 2015.

These findings are not entirely surprising given that TSA has been shown to be the most effective long-term treatment for glenohumeral arthritis. Although short-term functional outcomes have been shown to improve after HA, long-term success deteriorates over time such that revision rates of 43% over 7.5 years,[15] 25% over 11.3 years,[16] and 29% over 17.2 years[17] have been recorded. Sperling and Cofield[18] found 10- and 20-year revision rates to be 18% and 25% for HAs versus 3% and 16% for TSAs. A large systematic review found revision rates of 10.2% (HA) and 6.5% (TSA) over a mean of 43.4 months.[5]

Another factor that may account for the increasing use of TSAs is an inability to differentiate between TSA and RTSA using *ICD–9–CM* codes. However, in October 2010, the Centers for Disease Control and Prevention and the Centers for Medicare and Medicaid Services issued a new code (81.88) for RTSA.[11,19] Thus, the true impact of RTSA on the epidemiology of shoulder arthroplasty and the treatment of glenohumeral osteoarthritis remains to be determined. Nevertheless, as recently described by Kim and colleagues,[11] the number of TSAs performed for all indications accelerated significantly after the FDA approved RTSA in November 2003. RTSA improves pain and function when used for the treatment of glenohumeral joint degeneration associated with severe and irreparable rotator cuff arthropathy.[20-25] Given the recent national decline in HAs for osteoarthritis, RTSA may be replacing HA as the procedure of choice for arthritis associated with irreparable cuff tears.[25,26]

The present study had several significant epidemiologic findings. First, HA patients were younger than TSA patients. We hypothesize that surgeons may have selected HA in younger patients without extensive glenoid erosion to avoid the possibility of future glenoid loosening and to permit later conversion to TSA if required.[27] However, younger patients may

Table III. Hospital Charge, Length of Stay, Payer, and US Census Region, 2010

	Hemiarthroplasty		Total Shoulder Arthroplasty		*P*
	n	%	n	%	
Mean (SD) hospital charge	$37,949	($18,824)	$49,982	($23,106)	< .0001
Mean (SD) length of stay, d	2.0	(1.4)	2.1	(1.5)	.268
Payer					**< .0001**
Medicare	4385	61.3%	19,371	66.3%	
Medicaid	204	2.9%	593	2.0%	
Private insurance	2225	31.1%	8212	28.1%	
Self-pay	15	0.2%	40	0.13%	
No charge	4	0.05%	20	0.06%	
Other	307	4.3%	926	3.2%	
US Census Region	**Procedure Rate, per 100,000**				—[a]
Northeast	1.8		7.9		
Midwest	2.8		13.2		
South	2.4		9.4		
West	2.5		8.5		

[a]Unable to perform χ^2 test because of limited group size.

Table IV. Univariate Analysis of Inpatient Complications After Shoulder Arthroplasty, 2010

Incidence	Hemiarthroplasty	Total Shoulder Arthroplasty	*P*
Deaths	**0**	**10**	**.111**
Surgery or Care Complications	**295 (4.1%)**	**1797 (6.2%)**	**< .0001**
Cardiovascular Complications			
Total cardiac arrest	0	11	.103
Acute myocardial infarction	5	56	.027
Deep vein thrombosis	0	5	.259
Pulmonary embolism	0	49	.001
Cerebral vascular accident	5	25	.693
Total	10 (0.14%)	146 (0.5%)	< .0001
Infections			
Bacterial infection, unspecified site	26	100	.837
Pneumonia	20	117	.127
Urinary tract infection	96	469	.105
Total	142 (2.0%)	686 (2.3%)	.064
Blood Transfusions	**219 (3.1%)**	**1379 (4.7%)**	**< .0001**

Table V. Multivariate Logistic Regression of Complications, Adjusting for Significant Patient Characteristics and Comorbidities, That Were Independently More Highly Associated With Total Shoulder Arthroplasty Compared With Hemiarthroplasty

	Adjusted Odds Ratio	95% CI	*P*
Deaths	**—[a]**		
Surgery or Care Complications	**1.46**	**1.09-1.94**	**.011**
Cardiovascular Complications			
Total cardiac arrest	—[a]		
Acute myocardial infarction	2.26	0.26-17.62	.436
Deep vein thrombosis	—[a]		
Pulmonary embolism	—[a]		
Cerebral vascular accident	0.91	0.10-7.93	.930
Infections			
Bacterial infection, unspecified site	0.85	0.32-2.30	.754
Pneumonia	1.11	0.67-1.83	.692
Urinary tract infection	1.26	0.44-3.68	.667
Blood Transfusions	**1.40**	**1.01-1.94**	**.041**

[a]Unable to calculate adjusted odds ratio because of low complication rate.

be better served by TSA, as some authors have concluded that the overall rate of glenoid resurfacing after HA is higher than glenoid revision after TSA.[5] Furthermore, the strategy to convert to TSA after HA may in fact prove much more difficult than anticipated and yield unsatisfactory outcomes.[17]

In our study, women outnumbered men 1.4:1 for shoulder arthroplasty. An earlier investigation of the national TSA trend for the period 1990 to 2000 found the percentage of women who had TSA decreased significantly over the decade, from 65.7% to 57.1%.[9] We found that this downward trend continued, with women representing 53.7% of TSA patients in 2010. The earlier investigation also found a significant racial disparity in the population that had shoulder arthroplasty between 1998 and 2000; whites comprised 93% of the patient population.[9] In 2010, whites accounted for 76.3% of TSA patients and 78.4% of HA patients treated for arthritis, while making up 65.2% of the NIS database. Although the racial epidemiology of advanced glenohumeral arthritis has not been studied, these data suggest that non-whites are less likely to receive a shoulder arthroplasty for disabling shoulder pain and that this trend, while improving, has been ongoing for more than 20 years.[9,10] Finally, we report that the mean total hospital charge was $12,033 higher for TSA than HA. As no difference was identified between length of hospital stay for TSA versus HA, the difference in charge is most likely due to a combination of implant- and procedure-related costs.

In this study, we were limited to reports of intraoperative and postoperative complications. Such complications were recently studied in a 2010 Cochrane review that reported no differences in early adverse events for HA and TSA.[1] This finding was not confirmed nationally, as we noted a higher rate of complications of surgical procedures or medical care (CCS 238) in TSA discharges after adjusting for patient comorbidities. A multivariate analysis was necessary, as TSA patients were in poorer health than HA patients, as determined by their higher number of chronic illnesses and comorbidities, and thus would be expected to have more complications. This same multivariate analysis found that the rate of blood transfusions was significantly higher for TSA patients (4.7%) than for HA patients (3.1%). Overall, the national incidence of blood transfusions associated with shoulder arthroplasty for osteoarthritis was 5.8%. Higher rates have been documented in 2 investigations of transfusion in TSA and HA for all etiologies: 8.0% and 8.1% for TSA and HA

in one study,[28] and 6.1% and 4.1% in the other.[29] Neither study was able to identify a significant difference between transfusion rates, as was identified nationally in 2010.

One of the main limitations of national administrative datasets is the use and accuracy of *ICD–9–CM* diagnosis and procedure codes for identifying cases. Given that this dataset is not longitudinal, it provides only a snapshot of shoulder arthroplasty patients. Therefore, many factors, including outcomes and more long-term complications, cannot be assessed. Furthermore, the value of rates of inpatient complications is limited because these data are derived from hospital administrative databases, and comprehensive reporting of all inpatient complications may be inadequate. Despite these limitations, NIS has been used in multiple studies in orthopedic surgery and has been deemed highly concordant with the National Hospital Discharge Survey.[14,30,31]

Conclusion

The findings of our study highlight the recent growth in shoulder arthroplasty for the treatment of glenohumeral osteoarthritis. An ever increasing proportion of those procedures are TSAs. The 2010 increase represented the single largest yearly increase in volume of TSAs, whereas HA appears to be losing favor as a treatment modality. We are the first to report that, compared with HA, TSA is associated with significantly higher rates of complications of medical and surgical care and blood transfusions. Our results also corroborate the findings of earlier studies—that a higher proportion of women and white patients receive shoulder arthroplasties.

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Appendix. ICD–9–CM Procedure and Diagnosis Codes Used for Data Collection

Procedure	ICD–9–CM Code(s)
Total shoulder arthroplasty	81.80
Hemiarthroplasty	81.81
Diagnosis	
Glenohumeral arthritis	71511, 71521, 71531, 71591
Complications of surgical procedures or medical care, CCS 238	27661, 27783, 27788, 2853, 28741, 3490, 3491, 34931, 41511, 4294, 4582, 45821, 45829, 5121, 5122, 5187, 5190, 51900, 51901, 51902, 51909, 53086, 53087, 53640, 53641, 53642, 53649, 53901, 53909, 53981, 53989, 5642, 5643, 5644, 5696, 56962, 56971, 56979, 5793, 59681, 78062, 78063, 78066, 9093, 99524, 9954, 99586, 9970, 99700, 99701, 99702, 99709, 9971, 9972, 9973, 99731, 99732, 99739, 9974, 99741, 99749, 9975, 99760, 99761, 99762, 99769, 99771, 99772, 99779, 9979, 99791, 99799, 9980, 99800, 99801, 99802, 99809, 9981, 99811, 99812, 99813, 9982, 9983, 99830, 99831, 99832, 99833, 9984, 9985, 99851, 99859, 9986, 9987, 9988, 99881, 99882, 99883, 99889, 9989, 9990, 9991, 9992, 9993, 99934, 99939, 9994, 99941, 99942, 99949, 9995, 99951, 99952, 99959, 9996, 99960, 99961, 99962, 99963, 99969, 9997, 99970, 99971, 99972, 99973, 99974, 99975, 99976, 99977, 99978, 99979, 9998, 99980, 99981, 99982, 99983, 99984, 99985, 99988, 99989, 9999, V1553, V1580, V1583, V9001, V9009
Total cardiac arrest, CCS 107	42741, 42742, 4275
Acute myocardial infarction, CCS 100	4100, 41000, 41001, 41002, 4101, 41010, 41011, 41012, 4102, 41020, 41021, 41022, 4103, 41030, 41031, 41032, 4104, 41040, 41041, 41042, 4105, 41050, 41051, 41052, 4106, 41060, 41061, 41062, 4107, 41070, 41071, 41072, 4108, 41080, 41081, 41082, 4109, 41090, 41091, 41092
Deep vein thrombosis	45340, 45341, 45342
Pulmonary embolism	4151, 41511, 41512, 41513, 41519
Acute cerebral vascular accident, CCS 109	34660, 34661, 34662, 34663, 430, 431, 4320, 4321, 4329, 43301, 43311, 43321, 43331, 43381, 43391, 4340, 43400, 43401, 4341, 43410, 43411, 4349, 43490, 43491, 436
Bacterial infection, unspecified site, CCS 3	0200, 0208, 0209, 0218, 0219, 0228, 0229, 0230, 0231, 0232, 0233, 0238, 0239, 024, 025, 0260, 0269, 0270, 0271, 0272, 0278, 0279, 0300, 0301, 0302, 0303, 0308, 0309, 0312, 0318, 0319, 03289, 0329, 0330, 0331, 0338, 0339, 0341, 0363, 03681, 03689, 0369, 037, 0392, 0393, 0394, 0398, 0399, 0400, 0401, 0402, 0403, 04042, 04081, 04082, 04089, 0410, 04100, 04101, 04102, 04103, 04104, 04105, 04109, 0411, 04110, 04111, 04112, 04119, 0412, 0413, 0414, 04141, 04142, 04143, 04149, 0415, 0416, 0417, 0418, 04181, 04182, 04183, 04184, 04185, 04186, 04189, 0419, 390, 3929, 7953, 79531, 79539, V090, V091, V092, V093, V094, V0950, V0951, V096, V0970, V0971, V0980, V0981, V0990, V0991
Pneumonia, CCS 122	00322, 0203, 0204, 0205, 0212, 0221, 0310, 0391, 0521, 0551, 0730, 0830, 1124, 1140, 1144, 1145, 11505, 11515, 11595, 1304, 1363, 4800, 4801, 4802, 4803, 4808, 4809, 481, 4820, 4821, 4822, 4823, 48230, 48231, 48232, 48239, 4824, 48240, 48241, 48242, 48249, 4828, 48281, 48282, 48283, 48284, 48289, 4829, 483, 4830, 4831, 4838, 4841, 4843, 4845, 4846, 4847, 4848, 485, 486, 5130, 5171
Urinary tract infection, CCS 159	03284, 59000, 59001, 59010, 59011, 5902, 5903, 59080, 59081, 5909, 5950, 5951, 5952, 5953, 5954, 59581, 59582, 59589, 5959, 5970, 59780, 59781, 59789, 59800, 59801, 5990
Blood transfusion, CCS 222	9900, 9901, 9902, 9903, 9904, 9905, 9906, 9907, 9908, 9909

Abbreviations: ICD–9–CM, International Classification of Diseases, Ninth Revision, Clinical Modification; CCS, Clinical Classification Software.
For more details and for ICD–9 codes included in each CCS category, go to http://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp.

This paper will be judged for the Resident Writer's Award.