Patients with Systemic Sclerosis have higher healthcare utilization and Complication Rates after Total Hip Arthroplasty

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Abstract

Objective: To assess whether outcomes after primary total hip arthroplasty (THA) differ in Systemic Sclerosis (SSc).

Methods: We used the 1998-2014 U.S. National Inpatient Sample. THA and SSc were identified using procedure and diagnostic codes, respectively. Multivariable-adjusted logistic regression analyses assessed the association of SSc with in-hospital complications (implant infection, revision, transfusion, mortality) post-THA and associated healthcare utilization (hospital charges, hospital stay, discharge to non-home setting), adjusting for age, sex, race, Deyo-Charlson comorbidity index, primary diagnosis for THA, household income, and insurance payer..

Results: Of the 4,116,485 primary THAs performed in the U.S. 1998-2014, 2,672 (0.06%) had SSc. In multivariable-adjusted analyses, compared to people without SSc, people with SSc had higher adjusted odds ratios [OR] (95% confidence interval [CI]) of the following post-primary THA: (1) non-home discharge, 1.25 (95% CI, 1.03, 1.50); (2) hospital stay >3 days, 1.61 (95% CI, 1.35, 1.92); (3) transfusion, 1.54 (95% CI, 1.28, 1.84); and (4) revision, 9.53 (95% CI, 6.75, 13.46). Differences in mortality had a non-significant trend, 2.19 (95% CI, 0.99, 4.86). There were no differences in total hospital charges or implant infection rates.

Conclusion: SSc was associated with higher rate of in-hospital complications and healthcare utilization post-primary THA. Future studies should examine whether pre- or post-operative interventions can reduce the risk of post-THA complications in people with SSc.

Introduction

Systemic sclerosis (SSc), also called scleroderma, is a multisystem, chronic autoimmune disease characterized by skin thickening, Raynaud's phenomenon, and cardiopulmonary and gastrointestinal system involvement. Despite associated high morbidity and mortality burden of SSc (1), survival rates have improved over time (2). An improved survival puts SSc patients at risk of age-related diseases, such as end-stage hip arthritis, similar to the general population.

Total hip arthroplasty (THA) is a successful, common surgery for end-stage arthritis of the hip that improves pain, function and quality of life (QoL), and has a rapidly increasing utilization rate (3). The most common underlying causes for THA are osteoarthritis (OA), avascular bone necrosis (AVN) and rheumatoid arthritis (RA). Many previous studies have examined patient and surgeon characteristics, the underlying diagnosis (OA vs. RA vs. AVN vs. fracture) and medical comorbidity as potential predictors of THA outcomes (4). To our knowledge, THA outcomes have not been studied in SSc. Our study objective was to examine the independent association of SSc with THA outcomes, i.e., healthcare utilization and in-hospital complication rates, in a national U.S. cohort.

Methods

Data Source and Study Cohort Selection

Our study cohort included all hospitalizations for primary THA in the U.S. NIS 1998-2014 sample. NIS is the largest publicly available, de-identified all-payer inpatient health care database in the U.S. NIS consists of a 20% stratified sample of discharge records from all participating community hospitals from all participating states (5). It is that is extensively used for epidemiological studies of hospitalization, mortality and costs, since it represents all hospitalizations in the U.S.

We identified primary THA based on the presence of International Classification of Disease, ninth revision, common modification (ICD-9-CM) procedure code of 81.51, listed as the primary

procedure for hospitalization. This validated approach has positive predictive values of 98-99% (6, 7). The Institutional Review Board at the University of Alabama at Birmingham (UAB) approved this study.

Exposure, Outcomes and Covariates

The exposure of interest was the presence of SSc at index hospitalization, based on the presence of an ICD-9 code of 710.1 in a non-primary position during the index hospitalization, a validated approach with sensitivity of 80% and specificity of 95% (8). We examined the following outcomes post-primary THA: (1) health care utilization: total hospital charges (above the median for each calendar year), the length of hospital stay (above the median of 3 days), the discharge disposition to home vs. non-home settings (rehabilitation or inpatient facility); (2) in-hospital complications, implant infection, transfusion or revision, identified by respective ICD-9-CM codes; and in-hospital mortality.

We adjusted our main models for covariates/confounders, including age, sex, race, the underlying primary diagnosis for THA, household income, the insurance payer and Deyo-Charlson comorbidity index (9), a validated measure of medical comorbidity that includes 17 comorbidities with score ranging 0-25, higher score indicating more comorbidity load.

Statistical Analyses

We followed the survey analysis procedures that take into account the weights, clusters and strata as defined in NIS, including the modified weights with the change in sampling in 2012. Summary statistics were compared using chi-square or student's t-test, as appropriate. We performed multivariable-adjusted logistic regression analyses for each study outcome, adjusting for all covariates listed in the section above. Odds ratios (OR) and 95% confidence intervals (CI) were calculated.

Sensitivity analyses additionally adjusted the main analyses for hospital characteristics including hospital location/teaching status, bed size and region, previously associated with THA outcomes (6). We used SAS 9.3 (Cary, N.C.) for all analyses. We considered a p-value <0.05 to be statistically significant.

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Results

Of the 4,116,485 primary THAs performed in the U.S. 1998-2014, 2,672 (0.06%) had SSc (**Table 1)**. Compared to people without SSc, people with SSc were younger, and more likely to be female or have higher Deyo-Charlson comorbidity index score or an underlying diagnosis of avascular bone necrosis (**Table 1**). Unadjusted rates of in-hospital transfusion, revision, or death were higher in people with SSc (**Table 1**).

In multivariable-adjusted analyses, compared to people without SSc, people with SSc had higher odds of non-home discharge, hospital stay >3 days (**Table 2**), transfusion, or revision post-primary THA, with respective odds ratios of 1.25 (95% CI, 1.03, 1.50), 1.61 (95% CI, 1.35, 1.92), 1.54 (95% CI, 1.28, 1.84) and 9.53 (95% CI, 6.75, 13.46), respectively. Other variables significantly associated with outcomes are shown in **Table 2.** No differences were seen in total hospital charges or implant infection rates (**Table 2**); mortality rate was borderline significant and higher in SSc, 2.19 (95% CI, 0.99, 4.86; **Table 2**). Sensitivity analyses confirmed the main findings with minimal attenuation of odds ratios (**Appendix 1**).

Discussion

In a study using a U.S. national sample, SSc was associated with higher odds of non-home discharge, and longer hospital stay post-primary THA. SSc patients were also more likely to have in-hospital transfusion or revision surgery, and had a trend towards higher in-hospital mortality post-primary THA. Odds were higher ranging 1.25- to 10-fold, which are arguably clinically meaningful differences. We noted no association of SSc with total hospital charges or implant infection rates.

SSc-associated interstitial lung disease (ILD), pulmonary hypertension, acute renal failure, aspiration, pericarditis/cardiomyopathy and a higher infection risk may be responsible for a longer hospital stay in SSc patients (1, 10). A higher odds of non-home discharge in SSc patients might be related to a more protracted rehabilitation due to associated skin disease and arthritis (11) and/or a poorer social network (12). Physical rehabilitation reduces disability and improves function in people with SSc (13, 14). A tailored, multidisciplinary rehabilitation program is successful in SSc (15). Whether combining a SSc-specific rehabilitation program with THA-rehabilitation can improve quality of life in the post-THA period and reduce healthcare utilization remains to be seen. Pre-habilitation with SSc-focused program is a potential intervention that merits testing in SSc patients undergoing elective primary THA.

In-hospital transfusion rate in SSc was higher than those without SSc. A third of all SSc patients have anemia (16). Anemia of chronic disease and/or anemia related to iron deficiency from low oral intake, heavy menses or gastrointestinal blood loss secondary to gastric antral vascular ectasia or intestinal mucosal telangiectasias are common in SSc; microangiopathic hemolytic anemia may rarely contribute (17). Post-operative risk of gastrointestinal bleeding may be elevated after THA.

SSc patients had higher odds of in-hospital revision surgery. Unadjusted absolute revision rates were low, 0.4% in non-SSc vs. 1.8% in SSc, and adjusted odds were 10-fold higher in SSc. Instability, dislocation and peri-prosthetic fractures are common causes of early THA failure (18) leading to revision. The musculoskeletal morbidity in SSc may increase the risk of these complications post-THA (19). SSc-associated calcinosis and possibly higher general infection risk (1, 10) may also contribute. Interestingly, implant infection (another cause of revision) risk did not differ between SSc and non-SSc patients.

SSc patients had a non-significant trend towards higher mortality post-THA. Diabetes, anxiety and depression increased in-hospital mortality in hospitalized SSc patients (20); scleroderma renal crisis, ILD, pulmonary hypertension, pericarditis/cardiomyopathy, heart failure, and infections also contribute

to higher mortality (1, 10). Several complications can be avoided with a closer pre-, intra- and post-THA monitoring, by including the appropriate specialist/s in peri-operative period.

In our cohort of post-THA SSc patients, the hospital charges were higher ($38,964) and mortality (0.7%) lower compared to all SSc hospitalizations in the U.S. NIS data, at $8,885 and 5%, respectively (10). This should be expected, since for THA subsample in our study represents SSc patients who are fit enough to undergo a major surgery (elective in >75% cases), and where pre-operative comorbidity optimization is performed to reduce post-operative complications.

Our study strengths include the use of a national U.S. hospitalization sample, the adjustment of models for potential confounders, and the robustness of effect estimates in sensitivity analyses.

Our study has several limitations. The use of ICD-9-CM codes to identify people with SSc and with THA puts our study at the risk of misclassification bias. However, ICD-9-CM codes for SSc (8) and THA (6, 7) were valid in previous studies, indicating that this bias may be limited. We recognize that in-hospital complications constitute a small proportion of all post-THA complications. Lack of data on SSc clinical features at the time of hospitalization including SSc subtype and duration, skin scores, ILD, pulmonary hypertension, cardiac function, and calcinosis, limited our ability to examine the role of these disease severity factors on outcomes. Future studies that have the ability to conduct longitudinal outcome analyses at a patient-level are needed to better understand whether 30- and 90-day complications post-THA are or are not higher in people with SSc.

In conclusion, we conducted a national U.S. cohort study of primary THA hospitalizations among people with versus without SSc. We found that SSc was associated with a higher risk of in-hospital transfusion and revision surgery; a longer hospital stay; and higher discharge rates to a non-home setting. A non-significant trend towards higher in-hospital mortality was also noted in people with SSc. Future studies should assess the reasons for higher complication rates and healthcare use in people with SSc undergoing primary THA and design appropriate interventions.

Author contributions: Mr. Cleveland had full access to all of the data in the study and takes the responsibility for the integrity of the data and accuracy of the data analysis. He was supervised by Dr. Singh, who reviewed all results.

Study Concept and Design: Singh.

Data acquisition, analysis and interpretation of results: Singh, Cleveland

Drafting of the manuscript: Singh

Critical revision of the manuscript for important intellectual content: Singh, Cleveland

Statistical analysis: Cleveland

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References:

1. Chung L, Domsic RT, Lingala B, Alkassab F, Bolster M, Csuka ME, et al. Survival and predictors of mortality in systemic sclerosis-associated pulmonary arterial hypertension: Outcomes from the pulmonary hypertension assessment and recognition of outcomes in scleroderma registry. Arthritis Care Res (Hoboken) 2014;66:489-95.
2. Kennedy N, Walker J, Hakendorf P, Roberts-Thomson P. Improving life expectancy of patients with scleroderma: Results from the south australian scleroderma register. Intern Med J 2018;48:951-6.
3. Cram P, Lu X, Kaboli PJ, Vaughan-Sarrazin MS, Cai X, Wolf BR, et al. Clinical characteristics and outcomes of medicare patients undergoing total hip arthroplasty, 1991-2008. JAMA 2011;305:1560-7.
4. Hofstede SN, Gademan MG, Vliet Vlieland TP, Nelissen RG, Marang-van de Mheen PJ. Preoperative predictors for outcomes after total hip replacement in patients with osteoarthritis: A systematic review. BMC Musculoskelet Disord 2016;17:212.
5. Hcup databases. Healthcare cost and utilization project (hcup). Overview of the nationwide inpatient sample (nis). Https://www.Hcup-us.Ahrq.Gov/nisoverview.Jsp . Last modified 8/13/18. Rockville, MD: Agency for Healthcare Research and Quality; [cited 09/04/2019]; Available from.
6. Katz JN, Losina E, Barrett J, Phillips CB, Mahomed NN, Lew RA, et al. Association between hospital and surgeon procedure volume and outcomes of total hip replacement in the united states medicare population. J Bone Joint Surg Am 2001;83-A:1622-9.
7. Singh JA, Ayub S. Accuracy of va databases for diagnoses of knee replacement and hip replacement. Osteoarthritis Cartilage 2010;18:1639-42.
8. Bernatsky S, Linehan T, Hanly JG. The accuracy of administrative data diagnoses of systemic autoimmune rheumatic diseases. J Rheumatol 2011;38:1612-6.
9. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with icd-9-cm administrative databases. J Clin Epidemiol 1992;45:613-9.
10. Ram Poudel D, George M, Dhital R, Karmacharya P, Sandorfi N, Derk CT. Mortality, length of stay and cost of hospitalization among patients with systemic sclerosis: Results from the national inpatient sample. Rheumatology (Oxford) 2018;57:1611-22.
11. Casale R, Buonocore M, Matucci-Cerinic M. Systemic sclerosis (scleroderma): An integrated challenge in rehabilitation. Arch Phys Med Rehabil 1997;78:767-73.
12. Cinar FI, Unver V, Yilmaz S, Cinar M, Yilmaz F, Simsek I, et al. Living with scleroderma: Patients' perspectives, a phenomenological study. Rheumatol Int 2012;32:3573-9.
13. Antonioli CM, Bua G, Frige A, Prandini K, Radici S, Scarsi M, et al. An individualized rehabilitation program in patients with systemic sclerosis may improve quality of life and hand mobility. Clin Rheumatol 2009;28:159-65.
14. Maddali-Bongi S, Del Rosso A. Systemic sclerosis: Rehabilitation as a tool to cope with disability. Clin Exp Rheumatol 2016;34 Suppl 100:162-9.
15. Maddali Bongi S, Del Rosso A, Galluccio F, Tai G, Sigismondi F, Passalacqua M, et al. Efficacy of a tailored rehabilitation program for systemic sclerosis. Clin Exp Rheumatol 2009;27:44-50.
16. Westerman MP, Martinez RC, Medsger TA, Jr., Totten RS, Rodnan GP. Anemia and scleroderma: Frequency, causes, and marrow findings. Arch Intern Med 1968;122:39-42.

17. Frayha RA, Shulman LE, Stevens MB. Hematological abnormalities in scleroderma. A study of 180 cases. Acta Haematol 1980;64:25-30.
18. Melvin JS, Karthikeyan T, Cope R, Fehring TK. Early failures in total hip arthroplasty -- a changing paradigm. J Arthroplasty 2014;29:1285-8.
19. Pope JE. Musculoskeletal involvement in scleroderma. Rheum Dis Clin North Am 2003;29:391-408.
20. Amoda O, Ravat V, Datta S, Saroha B, Patel RS. Trends in demographics, hospitalization outcomes, comorbidities, and mortality risk among systemic sclerosis patients. Cureus 2018;10:e2628.

Table 1. Demographic and other cohort characteristics

	Entire cohort	No Systemic Sclerosis	Systemic Sclerosis
National Estimates*	N= 4,116,485*	N= 4,113,813*	N= 2,672*
Age in years, Mean (SE); median	65.2 (0.04); 65.9	65.5 (0.04); 66.0	63.6 (0.54); 64.5
Age category			
<50 years	449,642 (10.9%)	449,321 (10.9%)	321 (12.0%)
50-64 years	1,364,821 (33.2%)	1,363,891 (33.2%)	930 (34.8%)
65-79 years	1,732,014 (42.1%)	1,730,790 (42.1%)	1,224 (45.8%)
≥80 years	566,521 (13.8%)	566,324 (13.8%)	197 (7.4%)
Sex			
Female	2,330,188 (56.6%)	2,327,919 (56.6%)	2,269 (84.9%)
Male	1,776,722 (43.2%)	1,776,320 (43.2%)	402 (15.1%)
Race			
White	2,882,041 (70.0%)	2,880,179 (70.0%)	1,862 (69.7%)
Black	225,772 (5.5%)	225,583 (5.5%)	189 (7.1%)
Hispanic	104,385 (2.5%)	104,255 (2.5%)	130 (4.9%)
Other/Missing	904,234 (22.0%)	903,743 (22.0%)	491 (18.4%)
Deyo-Charlson Score			
0	2,193,575 (53.3%)	2,193,575 (53.3%)	0 (0.0%)
1	926,287 (22.5%)	924,825 (22.5%)	1,462 (54.7%)
≥2	996,624 (24.2%)	995,414 (24.2%)	1,210 (45.3%)
Primary Diagnosis			
Rheumatoid Arthritis	29,174 (0.7%)	29,099 (0.7%)	75 (2.8%)
Aseptic bone necrosis	285,622 (6.9%)	285,200 (6.9%)	422 (15.8%)
Osteoarthritis	3,447,224 (83.7%)	3,445,373 (83.8%)	1,851 (69.3%)
Other	354,307 (8.6%)	353,984 (8.6%)	323 (12.1%)
Fracture	117 (0.0%)	117 (0.0%)	0 (0.0%)
Insurance			
Medicaid	138,809 (3.4%)	138,727 (3.4%)	82 (3.1%)
Medicare	2,234,674 (54.3%)	2,233,071 (54.3%)	1,603 (60.0%)
Other	102,276 (2.5%)	102,246 (2.5%)	30 (1.1%)
Private	1,600,830 (38.9%)	1,599,902 (38.9%)	928 (34.7%)
Self	32,307 (0.8%)	32,293 (0.8%)	14 (0.5%)
Income Category			
0-25th percentile	653,243 (15.9%)	652,828 (15.9%)	415 (15.5%)
25-50th percentile	1,009,677 (24.5%)	1,009,042 (24.5%)	635 (23.8%)
50-75th percentile	1,086,953 (26.4%)	1,086,239 (26.4%)	714 (26.7%)
75-100th percentile	1,285,855 (31.2%)	1,284,984 (31.2%)	871 (32.6%)
Hospital Location/Teaching			
Rural	444,188 (10.8%)	444,031 (10.8%)	157 (5.9%)
Urban	1,722,390 (41.8%)	1,721,393 (41.8%)	997 (37.3%)
Urban Teaching	1,939,988 (47.1%)	1,938,471 (47.1%)	1,517 (56.8%)
Hospital Bed size			
Small	685,209 (16.6%)	684,783 (16.6%)	426 (15.9%)

Medium	1,037,562 (25.2%)	1,036,856 (25.2%)	706 (26.4%)
Large	2,383,797 (57.9%)	2,382,257 (57.9%)	1,540 (57.6%)
Hospital Region			
Northeast	818,699 (19.9%)	818,058 (19.9%)	641 (24.0%)
Midwest	1,089,883 (26.5%)	1,089,259 (26.5%)	624 (23.4%)
South	1,358,856 (33.0%)	1,357,985 (33.0%)	871 (32.6%)
West	849,045 (20.6%)	848,511 (20.6%)	534 (20.0%)
In-hospital Complications*** and Healthcare Utilization			
Infection	7,592 (0.2%)	7,588 (0.2%)	4 (0.2%)
Revision	17,931 (0.4%)	17,882 (0.4%)	49 (1.8%)
Transfusion	937,803 (22.8%)	936,912 (22.8%)	891 (33.3%)
Death	8,890 (0.2%)	8,871 (0.2%)	19 (0.7%)
Discharge Status			
Home	2,448,107 (59.5%)	2,446,763 (59.5%)	1,344 (50.3%)
Inpatient facility	1,649,103 (40.1%)	1,647,798 (40.1%)	1,305 (48.8%)
Length of Stay in days: Mean (SE); median	3.71 (0.01); 2.74	3.73 (0.01); 2.75	4.02 (0.11); 3.00
Length of Stay in days			
≤3	2,499,883 (60.7%)	2,498,544 (60.7%)	1,339 (50.1%)
>3	1,616,602 (39.3%)	1,615,270 (39.3%)	1,332 (49.9%)
Total Hospital Charges, in U.S. $, Mean (SE); Median	44,635 (268); 37,658	44,865 (269); 37,791	47,164 (1,526); 38,964
1998-2000	23,556 (275); 20,858	23,557 (275); 20,859	21,030 (991); 18,844
2001-2002	29,210 (431); 25,432	29,209 (431); 25,433	31,410 (3,509); 24,043
2003-2004	36,086 (598); 31,359	36,083 (599); 31,358	41,392 (4,074); 34,920
2005-2006	40,678 (623); 35,383	40,677 (623); 35,382	41,685 (3,618); 38,299
2007-2008	47,216 (787); 41,423	47,215 (788); 41,424	48,395 (4,782); 38,262
2009-2010	49,918 (1,062); 43,304	49,920 (1,061); 43,305	47,166 (3,034); 39,779
2011-2012	56,395 (848); 48,917	56,390 (848); 48,914	63,758 (4,187); 52,486
2013-2014	58,964 (532); 51,157	58,963 (532); 51,156	61,477 (3,953); 55,591

N (%), unless specified otherwise
SE, standard error

* U.S. National estimates were based on NIS, which is a 20% sample of all U.S. hospitalizations, details are available at: Https://www.Hcup-us.Ahrq.Gov/nisoverview.Jsp ; The actual numbers were entire cohort, n=855,634; No Systemic Sclerosis (N=855,079); and Systemic Sclerosis (N=555)
**Length of hospital stay dichotomized at 3 days, by rounding off the median of 2.7 days to 3 days
*** Infection was identified by the presence of ICD-9-CM code 711.xx, 730.xx, 996.66 or 996.67. Transfusion was identified with the ICD-9-CM code of 99.0x. Revision was identified with ICD-9-CM codes of 81.53, 00.70 00.72, 00.73, 84.56, 84.57 or 80.05

Table 2. Multivariable-adjusted association of SSc and other clinical variables with healthcare utilization outcomes and in-hospital implant infection, transfusion, revision and mortality post-primary THA*

	Total hospital charges above the median**	Discharge to non-home settings	Length of hospital stay >3 days	In-hospital Implant Infection	In-hospital Transfusion	In-hospital Revision Surgery	In-hospital Mortality
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Systemic Sclerosis	0.90 (0.76 ,1.07)	**1.25 (1.03, 1.50)**	**1.61 (1.35, 1.92)**	0.93 (0.22, 3.99)	**1.54 (1.28, 1.84)**	**9.53 (6.75, 13.46)**	2.19 (0.99, 4.86)
Age category							
<50 years	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
50 - 64 years	**0.86 (0.82, 0.90)**	**1.75 (1.71, 1.78)**	**1.09 (1.08, 1.11)**	0.97 (0.82, 1.16)	**1.11 (1.09, 1.13)**	0.96 (0.84, 1.11)	**0.77 (0.71, 0.83)**
65 - 79 years	**0.88 (0.84, 0.93)**	**3.36 (3.28, 3.44)**	**1.37 (1.35, 1.40)**	0.93 (0.74, 1.15)	**1.30 (1.26, 1.33)**	0.90 (0.76, 1.07)	0.90 (0.81, 1.01)
≥80 years	1.01 (0.95, 1.07)	**10.75 (10.46, 11.04)**	**1.95 (1.90, 1.99)**	0.94 (0.74, 1.19)	**1.85 (1.80, 1.90)**	0.92 (0.76, 1.11)	**2.50 (2.24, 2.80)**
Sex							
Male	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
Female	0.97 (0.95, 1.00)	**1.73 (1.71, 1.75)**	**1.20 (1.19, 1.21)**	0.95 (0.87, 1.04)	**1.68 (1.66, 1.70)**	1.01 (0.93, 1.09)	**0.91 (0.86, 0.97)**
Race/ethnicity							
White	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
Black	**0.61 (0.58, 0.64)**	**1.67 (1.63, 1.70)**	**1.38 (1.35, 1.41)**	1.16 (0.95, 1.41)	**1.39 (1.36, 1.42)**	**1.24 (1.05, 1.47)**	1.07 (0.92, 1.24)
Hispanic	**0.41 (0.39, 0.43)**	**1.40 (1.35, 1.44)**	**1.33 (1.29, 1.37)**	1.24 (0.96, 1.61)	**1.33 (1.29, 1.37)**	1.04 (0.83, 1.30)	0.86 (0.73, 1.01)
Other/missing	**2.50 (2.40, 2.61)**	**1.06 (1.05, 1.07)**	**1.39 (1.37, 1.40)**	1.04 (0.93, 1.16)	**0.93 (0.92, 0.94)**	1.10 (1.00, 1.22)	1.00 (0.93, 1.07)
Deyo-Charlson score							
0	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
1	**0.96 (0.93, 0.99)**	**1.20 (1.19, 1.22)**	**0.95 (0.94, 0.96)**	1.02 (0.91, 1.14)	**0.96 (0.95, 0.97)**	0.93 (0.84, 1.03)	**1.09 (1.02, 1.17)**
≥2	**0.75 (0.73, 0.78)**	**0.95 (0.94, 0.97)**	**0.58 (0.58, 0.59)**	1.04 (0.94, 1.16)	**0.78 (0.77, 0.79)**	0.92 (0.83, 1.01)	**1.46 (1.37, 1.55)**
Primary Diagnosis							
Rheumatoid arthritis	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
Aseptic bone necrosis	1.03 (0.89, 1.21)	**0.89 (0.84, 0.95)**	**0.84 (0.79, 0.89)**	1.53 (0.65, 3.60)	**0.82 (0.78, 0.88)**	1.25 (0.77, 2.02)	0.89 (0.59, 1.34)
Osteoarthritis	0.93 (0.80, 1.08)	**0.66 (0.62, 0.70)**	**0.51 (0.48, 0.54)**	0.85 (0.37, 1.96)	**0.66 (0.62, 0.69)**	0.84 (0.53, 1.32)	0.77 (0.53, 1.13)
Other	0.98 (0.84, 1.14)	**1.65 (1.55, 1.75)**	**2.30 (2.18, 2.43)**	**3.70 (1.59, 8.59)**	1.03 (0.97, 1.09)	**4.83 (3.04, 7.66)**	**7.22 (4.95, 10.53)**

Fracture	0.66 (0.09, 5.03)	**11.50 (3.39, 39.02)**	**11.84 (2.55, 54.85)**	Not Estimable	**1.16 (0.47, 2.82)**	Not Estimable	Not Estimable
Insurance payer							
Private	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
Medicare	0.99 (0.96, 1.03)	**2.06 (2.02, 2.09)**	**1.34 (1.32, 1.36)**	1.01 (0.86, 1.19)	**1.18 (1.16, 1.20)**	1.04 (0.91, 1.18)	**1.14 (1.04, 1.26)**
Medicaid	**1.38 (1.27, 1.51)**	**1.72 (1.67, 1.77)**	**1.70 (1.65, 1.74)**	**1.76 (1.43, 2.17)**	**1.17 (1.14, 1.21)**	**1.53 (1.28, 1.82)**	0.89 (0.75, 1.05)
Other	**1.92 (1.72, 2.14)**	**1.10 (1.06, 1.14)**	**1.32 (1.28, 1.37)**	**1.38 (1.06, 1.80)**	1.00 (0.97, 1.04)	1.04 (0.82, 1.32)	0.83 (0.69, 1.01)
Self	**1.24 (1.05, 1.46)**	**0.56 (0.52, 0.61)**	**1.50 (1.43, 1.58)**	1.30 (0.84, 2.03)	**1.11 (1.04, 1.18)**	**1.41 (1.01, 1.95)**	0.90 (0.64, 1.25)
Income category							
0-25th percentile	**2.48 (2.38, 2.59)**	**0.81 (0.80, 0.82)**	**0.86 (0.85, 0.87)**	0.96 (0.84, 1.10)	**0.82 (0.81, 0.84)**	0.98 (0.87, 1.11)	0.98 (0.90, 1.06)
25-50th percentile	**2.19 (2.12, 2.27)**	**0.83 (0.82, 0.84)**	**0.94 (0.93, 0.96)**	0.99 (0.88, 1.11)	**0.79 (0.78, 0.80)**	1.04 (0.94, 1.16)	0.99 (0.93, 1.07)
50-75th percentile	**1.55 (1.50, 1.60)**	**0.86 (0.85, 0.87)**	**0.91 (0.90, 0.92)**	0.99 (0.88, 1.12)	**0.79 (0.78, 0.81)**	0.99 (0.89, 1.10)	0.96 (0.89, 1.03)
75-100th percentile	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**

BOLD indicates significant odds ratio

OR, odds ratio; CI, confidence interval

An odds ratio >1 indicates that SSc patients had higher odds of that outcome, including in-hospital complication (e.g. mortality), healthcare utilization (charges, stay, discharge disposition). A 95% confidence interval that did not include unity (1.0) indicates that the association is statistically significant with a p-value <0.05.

***Model included the following variables:** age, sex, race, Deyo-Charlson comorbidity index, the underlying primary diagnosis for THA, household income, insurance payer, systemic sclerosis diagnosis

****Median hospital charges were as follows:** 1998, $19,717; 1999, $20,514; 2000, $22,333; 2001, $24,189; 2002, $26,729; 2003, $29,858; 2004, $32,607; 2005, $34,615; 2006, $36,164; 2007, $39,675; 2008, $43,064; 2009, $41,602; 2010, $45,186; 2011, $48,898; 2012, $48,927; 2013, $50,827; 2014, $51,482