How Systemic Sclerosis Affects Healthcare Use 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 US 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 use (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 THA performed in the United States in 1998–2014, SSc patients made up 0.06% (n = 2672). In multivariable-adjusted analyses, compared to people without SSc, people with SSc had higher adjusted OR (95% 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) in-hospital revision, 9.53 (95% CI 6.75–13.46). Differences in in-hospital mortality had a nonsignificant 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 a higher rate of in-hospital complications and healthcare use after primary THA. Future studies should examine whether pre- or postoperative interventions can reduce the risk of post-THA complications in people with SSc. (J Rheumatol First Release April 1 2020; doi:10.3899/jrheum.190783)

Key Indexing Terms:

SYSTEMIC SCLEROSIS	SCLERODERMA	ARTHROPLASTY
HIP	OUTCOMES	EPIDEMIOLOGY

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

Total hip arthroplasty (THA) is a common surgery for endstage arthritis of the hip that reduces pain and improves function and quality of life (QOL), and its use is rapidly increasing[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 use and in-hospital complication rates) in a national US cohort.

MATERIALS AND METHODS

Data source and study cohort selection. Our study cohort included all hospitalizations for primary THA in the US National Inpatient Sample (NIS) 1998–2014. NIS is the largest publicly available, deidentified all-payer inpatient healthcare database in the United States. NIS consists of a 20% stratified sample of discharge records from all participating community hospitals from all participating states[5]. It is extensively used for epidemiological studies of hospitalization, mortality, and costs, because it represents all hospitalizations in the United States.

We identified primary THA based on the presence of International Classification of Disease, 9th revision, Clinical 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 University of Alabama at Birmingham's Institutional Review Board

approved this study (UAB; X120207004) and waived the need for informed consent for this database study. All investigations were conducted in conformity with ethical principles of research.

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) healthcare use: 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 versus 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 a score ranging 0–25 (higher score indicating greater comorbidity load).

Statistical analyses. We followed the survey analysis procedures that take into account the weights, clusters, and strata as defined in the NIS, including the modified weights with the change in sampling in 2012. Summary statistics were compared using chi-square or Student t test, as appropriate. We performed multivariable-adjusted logistic regression analyses for each study outcome, adjusting for all covariates listed in the section above. OR and 95% 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 (SAS Institute Inc.) for all analyses. We considered a p value < 0.05 to be statistically significant.

RESULTS
Of the 4,116,485 primary THA performed from 1998 to 2014 in the United States, 2672 (0.06%) were done on patients with 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 1A). Unadjusted rates of in-hospital transfusion, revision, or death were higher in people with SSc (Table 1B).

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), in-hospital transfusion, or in-hospital revision post-primary THA, with OR 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; the mortality rate was borderline significant and higher in SSc (OR 2.19, 95% CI 0.99–4.86; Table 2). Sensitivity analyses confirmed the main findings with minimal attenuation of OR (Appendix 1).

DISCUSSION
In a study using a US national sample, SSc was associated with higher odds of non-home discharge, and a longer hospital stay after primary THA. Patients with SSc were also more likely to have in-hospital transfusion or revision

surgery, and had a trend toward higher in-hospital mortality after primary THA. Odds were higher, ranging from 1.5- 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 (HTN), acute renal failure, aspiration, pericarditis/cardiomyopathy, and a higher infection risk may be responsible for a longer hospital stay in patients with SSc[1,10]. Higher likelihood of non-home discharge in patients with SSc 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 an SSc-specific rehabilitation program with THA rehabilitation can improve QOL in the post-THA period and reduce healthcare use remains to be seen. Pre-habilitation with an SSc-focused program is a potential intervention that merits testing in patients with SSc who are undergoing elective primary THA.

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

Patients with SSc had higher odds of in-hospital revision surgery. Unadjusted absolute revision rates were low, 0.4% in non-SSc versus 1.8% in SSc, and adjusted odds were 10-fold higher in SSc. Instability, dislocation, and periprosthetic 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 patients with SSc and those without.

Patients with SSc had a nonsignificant trend toward higher mortality post-THA. Diabetes, anxiety, and depression increased in-hospital mortality in hospitalized patients with SSc[20]. Other examples of SSc-associated end-organ involvement that can also contribute to higher mortality include scleroderma renal crisis, ILD, pulmonary HTN, pericarditis/cardiomyopathy, and heart failure. The increased risk of infections likely contributes as well[1,10]. Several complications can be avoided with closer pre-, intra-, and post-THA monitoring, by including the appropriate specialist/s in the perioperative period.

In our cohort of post-THA patients with SSc, the hospital charges were higher (US$38,964) and mortality (0.7%) lower

Table 1A. Demographic and other cohort characteristics.

National Estimates*	Entire Cohort, n = 4,116,485*	No SSc, n = 4,113,813*	SSc, n = 2672*
Age, yrs, mean (SE); median	65.2 (0.04); 65.9	65.5 (0.04); 66.0	63.6 (0.54); 64.5
Age category, yrs			
< 50	449,642 (10.9)	449,321 (10.9)	321 (12.0)
50–64	1,364,821 (33.2)	1,363,891 (33.2)	930 (34.8)
65–79	1,732,014 (42.1)	1,730,790 (42.1)	1224 (45.8)
≥ 80	566,521 (13.8)	566,324 (13.8)	197 (7.4)
Sex			
Female	2,330,188 (56.6)	2,327,919 (56.6)	2269 (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)	1862 (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)	1462 (54.7)
≥ 2	996,624 (24.2)	995,414 (24.2)	1210 (45.3)
Primary diagnosis			
RA	29,174 (0.7)	29,099 (0.7)	75 (2.8)
Avascular bone necrosis	285,622 (6.9)	285,200 (6.9)	422 (15.8)
Osteoarthritis	3,447,224 (83.7)	3,445,373 (83.8)	1851 (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)	1603 (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)
25th–50th percentile	1,009,677 (24.5)	1,009,042 (24.5)	635 (23.8)
50th–75th percentile	1,086,953 (26.4)	1,086,239 (26.4)	714 (26.7)
75th–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)	1517 (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)	1540 (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)

compared to all SSc hospitalizations in the US NIS data, at $8885 and 5%, respectively[10]. This should be expected, because the THA subsample in our study represents patients with SSc who are fit enough to undergo major surgery (elective in > 75% cases), and in addition both perioperative evaluation and preoperative comorbidity optimization are performed (to some extent) in these patients to reduce postoperative complications.

Our study strengths include the use of a national US 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

Table 1B. In-hospital complications*** and healthcare use.

National Estimates*	Entire Cohort, n = 4,116,485*	No SSc, n = 4,113,813*	SSc, n = 2672*
Infection	7592 (0.2)	7588 (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	8890 (0.2)	8871 (0.2)	19 (0.7)
Discharge status			
Home	2,448,107 (59.5)	2,446,763 (59.5)	1344 (50.3)
Inpatient facility	1,649,103 (40.1)	1,647,798 (40.1)	1305 (48.8)
Length of stay, 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, days**			
≤ 3	2,499,883 (60.7)	2,498,544 (60.7)	1339 (50.1)
> 3	1,616,602 (39.3)	1,615,270 (39.3)	1332 (49.9)
Total hospital charges, US$, mean (SE); median	44,635 (268); 37,658	44,865 (269); 37,791	47,164 (1526); 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 (3509); 24,043
2003–2004	36,086 (598); 31,359	36,083 (599); 31,358	41,392 (4074); 34,920
2005–2006	40,678 (623); 35,383	40,677 (623); 35,382	41,685 (3618); 38,299
2007–2008	47,216 (787); 41,423	47,215 (788); 41,424	48,395 (4782); 38,262
2009–2010	49,918 (1062); 43,304	49,920 (1061); 43,305	47,166 (3034); 39,779
2011–2012	56,395 (848); 48,917	56,390 (848); 48,914	63,758 (4187); 52,486
2013–2014	58,964 (532); 51,157	58,963 (532); 51,156	61,477 (3953); 55,591

Values are n (%) unless otherwise specified. * US national estimates were based on the National Inpatient Sample, a 20% sample of all US hospitalizations; details are available at: 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. SSc: systemic sclerosis; SE: standard error; ICD-9-CM; International Classification of Diseases, 9th revision, Clinical Modification; RA: rheumatoid arthritis.

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 HTN, cardiac function, and calcinosis limited our ability to examine the role of these disease severity factors on outcomes. Future studies that include longitudinal outcome analyses at a patient level are needed to better understand whether 30- and 90-day complications post-THA are higher in people with SSc.

We conducted a national US 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 nonsignificant trend toward 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.

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

Variables	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
SSc	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, yrs							
< 50	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
50–64	**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	**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	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							
RA	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
Avascular 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, percentile							
0–25th	**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)
25th–50th	**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)
50th–75th	**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)
75th–100th	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**

Data are OR (95% CI). Values in bold face indicate significant OR. An OR > 1 indicates that SSc patients had higher odds of that outcome, including in-hospital complication (e.g., mortality) and healthcare use (charges, stay, discharge disposition). A 95% CI 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, SSc 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. SSc: systemic sclerosis; RA: rheumatoid arthritis; THA: total hip arthroplasty.

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APPENDIX 1. Sensitivity analyses* adjusting the main multivariable-adjusted models for hospital location/teaching status, region, and bed size, assessing the association of systemic sclerosis (SSc) with healthcare use and in-hospital complications.

	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
SSc	0.88 (0.74–1.04)	**1.23 (1.01–1.48)**	**1.62 (1.35–1.93)**	0.92 (0.22–3.92)	**1.54 (1.28–1.85)**	**9.55 (6.74–13.53)**	2.20 (0.97–5.02)

Data are OR (95% CI). * Model included age, sex, race, Deyo-Charlson comorbidity index, primary diagnosis, insurance, income, SSc (main model) plus hospital location/teaching status, region, and bed size. Data are OR (95% CI). Values in bold face are statistically significant.