Hospital Admissions, Length of Stay, Charges, and In-hospital Death Among Patients with Systemic Sclerosis

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ABSTRACT. ***Objective.*** To investigate population hospitalization rates to community hospitals for systemic sclerosis (SSc, scleroderma) and examine whether age, sex, race, and insurance status independently predict length of stay (LOS), hospital charges, and in-hospital death.

Methods. The 1995 Healthcare Cost and Utilization Project national inpatient sample was used to identify 3,621 SSc hospitalizations. Weighted age, sex, and race-specific frequencies were divided by population estimates to calculate hospitalizations per million people. Regression models were used to model LOS, charges, and in-hospital death with age, sex, race, and insurance serving as the primary independent variables. Covariates included numbers of diagnoses and procedures, whether or not the admission was a transfer from another hospital, and the presence of comorbid conditions.

Results. Population hospitalization rates were higher for non-whites compared to whites among those < 65, while rates were higher for whites compared to non-whites for those ≥65 years old. On average, non-whites were at least 10 years younger than whites. The mean LOS was 7.5 days, with whites' average LOS being 10% shorter than non-whites', and patients with public health insurance having approximately 9% longer LOS than those with private insurance. Charges averaged almost US$15,000 per hospitalization (median = $8,441), amounting to $280 million in community hospital charges in the U.S. in 1995. The overall in-hospital death rate was 7.1%.

Conclusion. These patterns are consistent with a greater burden and increased severity of disease among non-whites under age 65 with Ssc. (J Rheumatol 2001;28:2031–7)

Key Indexing Terms:

SCLERODERMA, SYSTEMIC	HOSPITALIZATION	LENGTH OF STAY
MINORITY GROUPS	HOSPITAL CHARGES	HOSPITAL MORTALITY

Systemic sclerosis (SSc, scleroderma) is a rare connective tissue disease most commonly characterized by skin thickening caused by an uncontrolled fibrotic process, affecting a wide variety of organ systems, including the lungs, esophagus and other portions of the gastrointestinal tract, kidneys, and digital blood vessels. Little research has focused on healthcare utilization by patients with SSc, or whether there are disparities in health services between whites and non-whites with SSc.

Although it is well-established that females are at increased risk of SSc[1], it also appears that the incidence of SSc is higher in blacks compared with whites. Steen, *et al* showed that SSc incidence in Allegheny County, Pennsylvania, was generally higher for blacks compared to whites, with the highest incidence occurring in black females, aged 45-54 (approximately 55 cases per million population)[2]. In addition, the incidence of SSc among male army veterans was shown to be greater among blacks (7.1 per million) than whites (1.9 per million)[3].

It also appears that non-whites with SSc may be affected more severely than whites by their disease. Investigators have demonstrated that certain clinical and serologic features differ by race. For example, Steen, *et al* showed that black patients with SSc were at greater risk for severe restrictive lung disease than whites[4], a trend verified by Greidinger, *et al* and Kuwana, *et al*[5,6]. In a study of women with SSc, Laing, *et al* showed that black women were more likely than white women to develop diffuse disease, be diagnosed at a younger age, have a higher incidence of inflammatory features (pericarditis, pulmonary hypertension, pleural effusion, myositis, and elevated erythrocyte sedimentation rate), and have lower age-adjusted survival[7].

Because SSc is such a rare disease, it is difficult to perform analyses that examine factors associated with healthcare utilization. Settings in which population-based studies of SSc are performed are often limited due to small numbers of cases. Studies in referral centers may be subject

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to bias associated with lack of transportation among poorer patients and greater disease severity among referral patients, both factors which may be related to healthcare utilization.

In 1995, the Healthcare Cost and Utilization Project (HCUP), administered by the Agency for Healthcare Policy and Research, collected hospital discharge data on 6.7 million hospitalizations from community hospitals in 19 states[8]. Data for the National Inpatient Sample database, one of several areas of focus of the HCUP, continues to be collected each year, approximating a 20% stratified sample of U.S. community hospitals. Data available include principal and up to 14 secondary diagnoses, principal and up to 14 secondary procedures, admission and discharge status, patient demographics (e.g., gender, age, and race), expected payment source (i.e. private insurance, Medicare, Medicaid, self-pay, other), length of stay (LOS), and total charges. Data are available from 6.7 million discharges in 1995; thus the HCUP database provides an excellent opportunity to examine health services research issues for many rare conditions.

The first aim of our study was to examine how population hospitalization rates differed by age, race, and sex. The second aim was to identify the demographic and clinical variables that predicted hospital LOS, total charges, and in-hospital death. The third aim was to compare white and non-white patients with Ssc admitted to the hospital to identify factors that may explain differences in healthcare resource utilization.

MATERIALS AND METHODS

Study design and patients. We performed a retrospective analysis of the 1995 HCUP National Inpatient Sample (NIS). Data from 19 US states were used, including Arizona, California, Colorado, Connecticut, Florida, Illinois, Iowa, Kansas, Maryland, Massachusetts, Missouri, New Jersey, New York, Oregon, Pennsylvania, South Carolina, Tennessee, Washington, and Wisconsin.

From the approximately 6.7 million hospitalizations, 3,621 admissions were identified with an ICD9-CM diagnosis code of 710.1, which includes acrosclerosis, progressive SSc, CREST syndrome, and scleroderma, and excludes localized scleroderma and morphea. No unique patient identifiers are included, so it was not possible to determine how many of the 3,621 hospitalizations were readmissions.

Population hospitalization rates to community hospitals. Community hospitals are defined as all nonfederal, short term, general and other specialty hospitals, excluding hospital units of institutions. Included among community hospitals are such specialty hospitals as obstetrics-gynecology, ear-nose-throat, short-term rehabilitation, orthopedic, and pediatric. Not included among community hospitals are longterm or psychiatric hospitals, and alcoholism and chemical dependency treatment facilities.

Population hospitalization rates to community hospitals for SSc by age, sex, and race were calculated. Variation in population hospitalization rates for certain subgroups may have several implications, including variation in disease incidence, severity, or mortality, and/or variation in access to appropriate outpatient care. For each age, sex, and race group, rates were expressed as the number of admissions to community hospitals per million people. Weights included in the HCUP dataset were summed over each observation to obtain the number of hospitalizations among the various age, sex, and race subgroups of patients with SSc within the 19 US states participating in the 1995 HCUP. Age, sex, and race specific population estimates were obtained from the U.S. Census for each of the 19 states. By dividing the number of hospitalizations by the states' population estimates for a given age, sex, and race subgroup, population hospitalization rates were determined. Age was classified into 4 groups: <35, 35 to 49, 50 to 64, and ≥65. Ninety-five percent confidence intervals were also calculated for each of the rates reported. In calculating these rates, race was classified as white (non-Hispanic) and black (non-Hispanic). Rates for other races were not determined; however, for the statistical modeling, race was classified into 2 groups: white and non-white, because after classifying patients as either white or black, there were too few observations (7%) in the remaining race/ethnic groups.

Comorbidity. The presence of comorbid conditions was determined for each hospital admission based on a modified version of Elixhauser's methodology[9]. Using ICD-9 codes, patients were classified as to whether or not they had one or more of the following conditions: congestive heart failure, arrhythmia, hypertension, valvular heart disease, pulmonary circulation disease, peripheral vascular disease, paralysis, other neurological disorders, chronic pulmonary disease, diabetes, diabetes with chronic complications, hypothyroidism, renal failure, liver disease, peptic ulcer disease with bleeding, acquired immune deficiency syndrome (AIDS), lymphoma, metastatic cancer, solid tumor without metastasis, rheumatoid arthritis/collagen vascular disease, coagulopathy, obesity, weight loss, fluid and electrolyte disorders, chronic blood loss anemia, deficiency anemias, alcohol abuse, drug abuse, psychoses, and depression. Any patient receiving hemodialysis was considered to have renal failure. In addition to these comorbidity measures, indicators for secondary pulmonary hypertension and pulmonary fibrosis were created using a combination of ICD-9 and DRG codes. Thus by incorporating these comorbidity indicators in the predictive models, we were able to determine the degree to which each comorbidity measure affected the outcome of interest.

Statistical models. Statistical models were created to determine predictors of hospital LOS, total charges, and in-hospital death. For models including LOS and total charges as dependent variables, linear regression models were used. Prior to the model construction, a logarithmic transformation was applied to the LOS and charge data due to the heavily skewed nature of the data. This transformation is common in this type of analysis, since the transformed variable more closely approaches a normal distribution than the untransformed variable, thus fulfilling assumptions of the linear regression models[10]. For in-hospital death, a logistic regression model was created, with death serving as the dependent variable. For all of the models, SUDAAN® (Research Triangle Institute, Research Triangle Park, NC) was used to account for the complex sampling frame used in the HCUP data collection processes.

In each of the 3 models, independent variables included age, race, sex, health insurance status, the number of procedures performed, the number of diagnoses, and whether or not the patient had been transferred from another hospital. Insurance status was classified as public (Medicare, Medicaid), private (including health maintenance organizations), or other (including self-pay and no charge). Initially, indicator variables for each of the comorbid conditions were also included, with the exception of AIDS, since none of the patients with SSC were diagnosed with AIDS. For each of the models, a backwards selection process was used to remove those comorbid conditions that were not moderately ($p < 0.10$) associated with the outcome of interest. Models predicting LOS and charges that excluded in-hospital deaths were also created to determine whether any observed associations between the independent and dependent variables were affected by the presence of hospitalizations that resulted in patients' deaths.

RESULTS

Population hospitalization rates. After applying the appropriate sampling weights to each of the discharges, analysis indicated that there were 18,740 (95% CI = 17,419 to 20,061) discharges from community hospitals among

patients with SSc in the U.S. in 1995. Population hospitalization rates to community hospitals for each age, sex, and race subgroup are shown in Table 1. Due to small numbers of hospitalizations in certain age and race groups for men, some rates could not be considered reliable, as their confidence intervals ranged from 0 to infinity. As expected, the overall rate for women [116.4 per million (95% CI 107.9 to 125.0)] was markedly higher than that for men [23.2 per million (95% CI 20.8 to 25.5)]. For both sexes combined, the overall rate was 70.9 per million (95% CI 65.8 to 76.0). Overall, the population hospitalization rate for blacks was not significantly higher than whites for either males or females. However, for the age groups younger than 65, the rates for blacks were significantly higher than those for whites. For those aged 65 and older, black men had similar rates to white men, while black women had significantly lower rates than white women.

Hospital LOS, total charges, and in-hospital death. Table 2 lists the average hospital LOS and total charges in addition to the percentage of patients who died for several groups of patients. Both LOS and total charges were heavily skewed, as means were substantially greater than the medians for all subgroups of interest. The mean LOS was 7.5 days, with a median of 5.0 days. The mean hospital charges were $14,948, with a median of $8,441. The overall in-hospital death rate was 7.1%. The analysis indicated that in 1995 there were over $280 million in hospital charges for admissions to US community hospitals among patients with SSc.

Predictors of hospital LOS. In the linear regression analysis, congestive heart failure was associated with significantly ($p < 0.001$) increased LOS, while arrhythmia and hypertension were associated with significantly ($p < 0.001$) decreased LOS. Secondary pulmonary hypertension, lung fibrosis, and kidney failure were not associated with hospital LOS. In addition, the following comorbid conditions were included as moderately significant ($p < 0.10$) predictors of hospital LOS: peripheral vascular disease, metastatic cancer, weight loss, electrolyte disorders, psychoses, hypothyroidism, and chronic blood loss anemias. After adjusting for the presence of these comorbidities, the number of procedures performed, and the number of other diagnoses, greater LOS was significantly ($p < 0.05$) associated with being non-white, older age, having public health insurance, and being transferred in from another hospital. LOS was not significantly different by gender. Table 3 summarizes these results, listing each of the variables included in the final model, p values, and percent change in LOS. Whites had a 10% shorter LOS, on average, than non-whites, and patients with private health insurance had an 8.8% shorter LOS than those with public health insurance, even after adjusting for all the other variables in the model. With exception of peripheral vascular disease, all significant associations remained significant when the analysis excluded patients who died in the hospital.

Predictors of total hospital charges. Congestive heart failure was associated with significantly ($p < 0.05$) increased charges, while hypertension was associated with significantly ($p < 0.05$) decreased charges. Arrhythmia, secondary pulmonary hypertension, pulmonary fibrosis, and kidney failure were not significantly associated with hospital charges. Other comorbid conditions that were moderately associated ($p < 0.10$) with increased total hospital charges included valvular heart disease, peripheral vascular disease, coagulopathy, weight loss, psychoses, while hypothyroidism, chronic blood loss anemias, drug abuse, and depression were associated with decreased charges. After adjustment for the presence of these comorbidities, the number of procedures performed, and the number of other diagnoses, greater hospital charges were significantly ($p < 0.05$) associated with older age and being transferred from another hospital. There was no significant difference in hospital charges for whites versus non-whites, for males versus females, or for those with public versus private health insurance. All significant associations remained significant when the analysis excluded those patients who died in the hospital.

Predictors of in-hospital death. The results from the logistic model examining predictors of in-hospital death are summarized in Table 4. Congestive heart failure was associated with a 1.7-fold increased risk of in-hospital death ($p < 0.05$), while pulmonary fibrosis was associated with a 2.7-fold increase in the risk of in-hospital death ($p < 0.0001$). Among

Table 1. Community hospital admissions for SSc per million population by age, race, and sex.

	Males				Females			
Age Group	White	95% CI	Black	95% CI	White	95% CI	Black	95% CI
0–34	1.3	(0, ∞)*	4.1	(0, ∞)	11.6	10.6, 12.6	32.7	26.8, 38.6
35–49	20.0	15.7, 24.3	67.3	33.0, 101.6	72.8	63.9, 81.7	157.7	132.2, 183.1
50–64	41.8	36.4, 47.1	63.1	22.7, 103.5	206.1	188.9, 223.4	301.1	255.4, 346.8
65+	71.6	59.4, 83.7	78.4	(0, ∞)	315.7	287.6, 343.8	240.0	174.1, 306.0
Total	21.1	18.4, 23.7	28.4	21.8, 35.6	109.7	101.3, 118.1	111.5	93.4, 129.7

CI: Confidence interval.
* Due to small numbers of patients in several strata, we were not able to calculate confidence intervals indicating that the corresponding rates are highly unstable.

Table 2. Hospital length of stay, charges, and in-hospital death for patients with SSc.

	N	Length of Stay (Days) Mean	Median	Hospital Charges Mean	Median	In-hospital Death (%)
Patient group						
< 35 yrs	229	5.4	3.0	$10,406	$6,627	3.3
35–49 yrs	696	6.9	4.0	$14,425	$7,183	3.7
50–64 yrs	1,071	7.7	5.0	$16,177	$8,447	7.1
≥ 65 yrs	1,624	7.9	6.0	$14,984	$9,159	9.1
Male	587	8.0	5.0	$17,335	$8,371	8.3
Female	3,034	7.4	5.0	$14,476	$8,451	6.9
White	2,337	7.4	5.0	$14,871	$8,387	7.0
Non-white	653	8.1	5.0	$16,656	$8,874	5.6
Number of procedures						
0	1,338	5.3	4.0	$7,482	$5,572	5.9
Hospitalization for systemic sclerosis						
1	820	5.7	5.0	$10,018	$7,665	3.9
2	550	7.0	5.0	$13,600	$9,426	5.6
≥ 3	913	12.8	9.0	$31,588	$18,249	12.8
Number of diagnoses						
≤ 3	398	4.0	3.0	$7,935	$5,696	1.3
4–6	1,295	5.4	4.0	$9,535	$6,463	4.0
7–9	1,385	8.8	6.0	$17,950	$10,193	9.4
≥ 10	543	11.7	8.0	$25,263	$13,240	12.9
Insurance						
Public	2,330	7.9	5.0	$15,300	$8,823	7.6
Private	1,128	6.8	4.0	$14,047	$7,783	6.1
Other	153	6.9	4.0	$16,545	$7,076	7.9
Admission source						
Non-transfer	3,362	7.3	5.0	$14,439	$8,285	7.0
Transfer	155	12.3	9.0	$22,299	$12,749	12.2
All hospitalizations	3,621	7.5	5.0	$14,948	$8,441	7.1

all the admissions for SSc, patients with hypertension were approximately half as likely to die in the hospital than those without ($p < 0.01$). Although those with secondary pulmonary hypertension were almost 30% more likely to die than those without, this association was not statistically significant. In addition, the associations of arrhythmias and kidney failure with death approached but did not achieve statistical significance ($p < 0.10$). In an analysis of all of the other comorbid conditions that were entered into the logistic model, predictors of increased odds of in-hospital death included liver disease ($p < 0.05$), metastatic cancer ($p < 0.0001$), coagulopathy ($p < 0.10$), and fluid and electrolyte disorders ($p < 0.01$), while obesity ($p < 0.0001$), alcohol abuse ($p < 0.0001$), and depression ($p < 0.10$) were found to be predictors of decreased odds of in-hospital death among patients with SSc. After adjusting for comorbid conditions and the number of procedures and diagnoses, in-hospital death was significantly ($p < 0.05$) associated with older age and being transferred from another hospital, while no statistically significant association was observed between in-hospital death and sex, race, or insurance status. The overwhelming majority of the 262 deaths could be explained by pulmonary fibrosis, secondary pulmonary hypertension, congestive heart failure, arrhythmia, or kidney failure, present in 27, 14, 41, 23, and 16% of in-hospital deaths, respectively; however, 26% of patients died of other causes, including digestive system disorders, liver disorders, and infection.

Although a larger proportion of whites appeared to have died overall, this is due to more whites dying than non-whites among those aged 65 and older (whites: 8.9, non-whites: 5.9%). However, in those less than age 65, non-whites were more likely to die than whites (< 35 yrs: 4.2 vs 1.2%; 35-49 yrs: 4.7 vs 2.7%; 50-64 yrs: 6.9 vs 6.8%).

Racial differences in admissions for SSc. Since population hospitalization rates were significantly different between whites and blacks in the younger age groups, and since race was found to be an important predictor of hospital LOS, differences between whites and non-whites were examined further. On average, whites were significantly older than non-whites (62.6 vs 52.4 yrs, $p < 0.0001$) and significantly less likely to be on Medicaid (4.7 vs 24.1%, $p < 0.0001$). Whites were found to have statistically similar numbers of procedures (1.7) and diagnoses (7.1) as non-whites (1.9 and 6.9, respectively), and similar rates of being transferred

Table 3. Predictors of hospital length of stay.

Variable	p Value	Percent Increase or (Decrease) in LOS*
White (reference:non-white)	0.0043	(10.4)
Female (reference:male)	0.9161	0.4
Age (yrs)	0.0001	0.6
Number of procedures	0.0001	14.5
Number of diagnoses	0.0001	7.9
Private insurance (reference:public)	0.0033	(8.8)
Other insurance (reference:public)	0.0340	(19.0)
Hospital transfer	0.0001	41.9
Comorbid conditions		
Congestive heart failure	0.0002	14.9
Arrhythmias	0.0004	(14.3)
Hypertension	0.0001	(11.0)
Secondary pulmonary hypertension	0.5001	4.6
Pulmonary fibrosis	0.8851	0.6
Kidney failure	0.8122	1.3

* For categorical variables such as race, sex, and insurance, the percentage increase or decrease in LOS is in reference to the reference group listed. For continuous variables (age, number of procedures, and number of diagnoses), the percentage increase or decrease in LOS listed is for a 1 unit increase in the variable in question (e.g., for each additional procedure performed, the average LOS is increased by 14.5%). For comorbid conditions, the reference group consists of those without the condition of interest.

Table 4. Predictors of in-hospital death among patients with SSc.

Variable	Odds Ratio*	95% CI
White (reference:non-white)	1.19	(0.75, 1.89)
Female (reference:male)	0.73	(0.50, 1.08)
Age	1.02	(1.01, 1.04)
Number of procedures	1.20	(1.12, 1.28)
Number of diagnoses	1.07	(1.01, 1.13)
Private insurance (reference:public)	1.16	(0.80, 1.68)
Other insurance (reference:public)	1.54	(0.69, 3.46)
Hospital transfer (reference:not a transfer)	2.38	(1.19, 4.75)
Comorbid conditions		
Congestive heart failure	1.73	(1.12, 2.68)
Arrhythmias	1.43	(0.96, 2.15)
Hypertension	0.56	(0.37, 0.85)
Secondary pulmonary hypertension	1.28	(0.75, 2.17)
Pulmonary fibrosis	2.67	(1.73, 4.12)
Kidney failure	1.55	(0.96, 2.52)

Adjusted odds ratios (OR) and their 95% confidence intervals (CI) are reported. CI that include 1 are not statistically significant at the $p < 0.05$ level.

* For categorical variables such as race, sex, and insurance, the adjuted OR is in reference to the reference group listed. For continuous variables (age, number of procedures, and number of diagnoses), the OR listed is for a 1 unit increase in the variable in question (e.g., for each additional procedure performed, the odds of dying in-hospital are increased by 20%). For comorbid conditions, the reference group consits of those without the condition of interest.

from another hospital (whites: 4.2, non-whites 3.6%). After adjusting for age, there were significant ($p < 0.05$) differences between whites and non-whites in the proportion with congestive heart failure (white: 19.3; black 20.3%), pulmonary circulation disease (white: 6.8; non-white: 9.3%), secondary pulmonary hypertension (white: 6.1; non-white: 8.4%), hypertension (white: 25.4; non-white: 25.7%), paralysis (white: 1.2; non-white: 3.6%), diabetes (white: 5.6; non-white: 9.9%), hypothyroidism (white: 10.5; non-white: 11.9%), metastatic cancer (white: 2.0; non-white: 0.3%), fluid and electrolyte disorders (white: 24.6; non-white: 28.1%), and depression (white: 4.7; non-white: 3.0%).

DISCUSSION

Our results demonstrate that population hospital admission rates to community hospitals for SSc differ substantially by age, sex, and race. Hospitalization rates are greater for women compared to men, and rates tend to increase with age. Hospitalization rates for those younger than 65 are greater among blacks than whites. Among those over age 65, hospitalization rates are similar among white and black men, and significantly higher for white women compared to black women. This may be explained by higher mortality among black women at younger ages. These patterns are consistent with known age and sex specific incidence rates of SSc, and are consistent with a greater burden of disease among the black population under age 65.

Hospitalizations for SSc account for a significant proportion of healthcare expenditures. These results, suggesting that community hospital charges, over $280 million for patients with SSc in 1995, are greater than those estimated in an earlier study in 1994. An economic evaluation of the direct and indirect costs of SSc estimated that there were 13,000 discharges for SSc from US short stay hospitals (those with an average LOS of less than 30 days) in 1994, with an average LOS of 7.2 days and $10,433 in total hospital charges, totaling almost $136 million in charges. Adjusting this estimate to 1995 dollars using a 4.5% increase in the consumer price index for healthcare would bring the total to $142 million, still short of our estimate of $280 million. Several factors may explain the difference between the earlier estimate and the current one. The earlier charge estimates were based only on estimates from only one US state (Maryland), and the universe of short stay hospitals is somewhat different from the universe of community hospitals used in our study. One explanation of the larger estimate of numbers of hospitalizations may be that the NIS sample of hospitals is slightly over-representative of large hospitals[12].

Several factors are associated with greater hospital LOS, total charges, and in-hospital death. Age, race, insurance status, hospital transfer status, numbers of procedures and diagnoses, as well as certain comorbid conditions, were all predictors of LOS. As non-white race and having public

health insurance are often associated with lower socioeconomic status (SES) and poorer outcomes for other diseases, further inquiry may be warranted into determining the effects of lower SES on the clinical outcomes of patients with SSc. Older age was also associated with both increased hospital charges and increased rates of in-hospital death after adjusting for the presence of selected comorbid conditions, number of procedures, and number of diagnoses. These results were all independent of whether or not SSc was listed as the principal diagnosis, as the diagnosis position did not have an effect on LOS, total charges, or in-hospital death.

It may seem surprising that hypertension is significantly associated with decreased LOS, charges, and mortality. Among all patients with SSc, hypertension is probably not protective of poor clinical outcomes; however, because the sample in this study is constructed from patients with SSc who are sick enough to warrant hospital admission, the admissions for SSc with hypertension are less likely to require a longer LOS, incur greater charges, or die than the patients with SSc admitted with other, more serious complications. With angiotensin converting enzyme inhibitors and other potent anti-hypertensive drugs available now and during the period of time from which our data were derived, hypertension in SSc is often very responsive to therapy, thus allowing for a shorter LOS than with other, less responsive, complications of SSc requiring hospitalization. It may also be surprising that secondary pulmonary hypertension was not found to be a significant predictor of in-hospital death. In an unadjusted analysis, this condition was a significant predictor, as those with secondary pulmonary hypertension were 2.5 times as likely to die in hospital as those without ($p < 0.0001$). However, in the full model in which other factors were considered, the association between pulmonary hypertension and in-hospital death was attenuated, as the adjusted odds ratio fell to 1.28 and was no longer statistically significant ($p = 0.36$).

These results also highlight some important differences between whites and non-whites with SSc. On average, non-whites had longer hospital stays than whites. In addition, non-whites were approximately 10 years younger, on average, than whites and were more likely to have Medicaid as their primary source of payment. The distribution of comorbid conditions is also quite different between whites and non-whites, suggesting that other disease processes may be influencing the health of whites and non-whites differently, or that conditions resulting from SSc may be distributed differently between whites and non-whites. These racial disparities likely reflect greater disease severity in non-whites. Race and health insurance were associated with LOS, but not with hospital charges or death during hospital admission; race does not appear, therefore, to be associated with a lower intensity of services or reduced survival among patients with SSc admitted to hospital. However, if access to ambulatory care helps prevent or delay the onset of severe disease among patients with SSc, then the racial differences observed in these data may also be somewhat explained by differences in access to appropriate and necessary ambulatory care. Future prospective studies could help identify the source of these discrepancies.

Our study has several strengths. Most importantly it quantifies how SSc affects whites and non-whites differently. The study analyzed inpatient stays from a national sample of community hospitals, and has the largest number of hospitalizations for SSc that have been analyzed for LOS, charges, and mortality. Because the proper statistical software for analysis of surveys with complex sampling frames was used, the results may be extrapolated to apply to the entire US. The NIS dataset is a sample of all hospitalizations to community hospitals, and it is possible that the hospitalizations for SSc included in the sample of hospitals differs from the universe of all hospitalizations for SSc in the US due to sampling error. Our analysis includes estimates of the magnitude of these potential effects in the sample weight used in our estimates and confidence intervals.

Although only 19 states are included in the NIS data, the data are meant to be a nationally representative sample of community hospitals. A recent report found that most statistics from NIS data were relatively consistent with those obtained from the National Hospital Discharge Survey (NHDS), particularly those for region and patient characteristics[12]. We found some differences between the NIS and NHDS discharge estimates; however, when discharges were stratified by hospital size, the average LOS were relatively similar. NIS estimates of in-hospital mortality rates may be slightly higher than the NHDS estimates in all regions except the Northeast. Although these discrepancies exist between the NIS and NHDS data, analyses like ours are not likely to be biased significantly, as evidence by the many publications from HCUP data that claim generalizability to the entire US[13-15].

Our study is also limited by several factors, primarily due to limitations of the HCUP data. Hospitalizations for SSc were selected by ICD9-CM codes, which introduces the possibility of error with regard to classification of disease. For example, patients with systemic fibrosclerosing syndrome (ICD-9 code 710.8) or other types of collagen disease (ICD-9 code 710.9) may have been misclassified as SSc or vice versa. In addition, there may have been other types of coding errors, because administrative datasets are usually not designed with the rigor normally used in research settings. Diagnoses and procedure coding policies are also likely to differ from one hospital to another. Since the southern region of the US may be under-represented in these data, some of the discrepancies in community hospitalization rates between whites and blacks may be slightly understated; however, our results were consistent across the Northeastern, Midwestern, Western, and Southern regions

of the US. In addition, since there were no patient identifiers, it was not possible to identify patients with multiple hospitalizations, and thus the assumption of independence across observations was likely violated to some degree. Any bias introduced by this limitation should be small, however, since data from the American Rheumatology Association Information System and Northern California Hospital Data indicated that the average number of hospital days per year for patients with SSc was 1.6, with men spending slightly more days (1.8) in hospital, on average, than women (0.8)[11]. In addition, since the units of analysis are the hospitalizations rather than the individual patients, total annual charges and hospital days for individual patients cannot be accurately estimated.

Although total hospital charges may differ from hospital costs and reimbursements, charges are an indication of the intensity of hospital services provided. The results indicating that charges may be significantly different across different types of payers may be more due to variation in the manner in which charges are filed in different hospitals rather than greater intensity of services among those with public health insurance.

This is the largest study to date of the hospital services, charges for services, and hospital mortality for SSc. Patterns of hospital admissions are consistent with patterns of occurrence of SSc in the general population. Although SSc is a rare condition, charges for community hospital services for patients with SSc are estimated to be $280 million in 1995. This estimate does not include charges for care received at federal facilities, charges for any ambulatory care, or any indirect costs of SSc; thus the total societal cost is likely to be substantially higher. After adjusting for markers of disease severity (number and types of comorbid conditions, number of procedures performed), non-white patients still had longer hospital stays than whites. The odds of in-hospital death were slightly lower in whites compared to non-whites, although this was not statistically significant. To better understand these racial disparities, further studies are needed to examine clinical differences between blacks and whites with SSc, the effect of lower socioeconomic status on hospital admissions and LOS, and the relationship of access to ambulatory services on the uses, charges, and outcomes of hospital services for patients with SSc.

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