

Demographic and Clinical Factors Associated with In-Hospital Death Among Patients with Systemic Sclerosis

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ABSTRACT. Objective. To examine demographic and clinical predictors of in-hospital death of patients with systemic sclerosis (SSc) and determine to what extent apparent racial differences may be attributed to socioeconomic factors.

Methods. Data were obtained on all hospitalizations in South Carolina for patients who were ever hospitalized between 1996 and 2000 with a diagnosis of SSc. Multiple logistic regression was used to examine predictors of in-hospital death among whites, blacks, and other patients.

Results. Proportions of in-hospital deaths among blacks (23.0%) and others (27.7%) were higher than among whites (15.6%), a finding that remained after adjustment for other sociodemographic and clinical factors (black/white odds ratio: 1.70, 95% confidence interval: 1.01–2.86; other/white OR 2.06, 95% CI 1.04–4.09). Other factors associated with in-hospital death included transfer status, emergency admission, length of stay, number of hospitalizations during the time period, and presence of congestive heart failure (OR 1.79; 95% CI 1.06–3.03) or hypertension (OR 0.41; 95% CI 0.23–0.71).

Conclusion. Black and other non-white patients with SSc appear to experience an elevated risk of death during their hospital stays. Further research is necessary to understand the reasons for these disparities. (J Rheumatol 2005;32:1888–92)

Key Indexing Terms:

SYSTEMIC SCLEROSIS
CONTINENTAL POPULATION GROUPS

HOSPITAL MORTALITY
RACIAL DISPARITIES

Systemic sclerosis (SSc, scleroderma) is typically characterized by skin thickening and abnormal fibrotic processes affecting a wide variety of organ systems, including lungs, esophagus and other portions of the gastrointestinal (GI) tract, kidneys, heart, and digital blood vessels. These complications contribute to significantly increased mortality rates compared to the general population¹. Over the past 30 years, the proportion of deaths among patients with SSc due to renal crisis has dramatically decreased, while the proportion due to pulmonary fibrosis has increased. Pulmonary hypertension and pulmonary fibrosis account for roughly 50% of SSc-related deaths and 25% of all deaths in this population². Cancer has also been shown to account for about

12–20% of deaths^{2,3}. Absolute survival has recently been estimated to be 77.9% at 5 years, 55.1% at 10 years, and 26.8% at 20 years¹.

Several studies in different locations have examined patient characteristics associated with increased mortality rates. Significant independent predictors of worse prognosis or increased mortality include male sex; age at diagnosis; renal, pulmonary, GI, or muscle involvement; proteinuria; elevated erythrocyte sedimentation rate; low levels of hemoglobin; low carbon monoxide diffusing capacity; diffuse cutaneous disease classification; presence of anti-Scl-70 antibody; and absence of anticentromere antibody^{1,3-7}.

We previously studied predictors of hospital mortality among SSc patients⁸ using a national administrative hospitalization reporting database because many SSc deaths are likely to occur during an inpatient hospital stay. That study, along with a prior analysis of a statewide hospitalization administrative database, suggested that race/ethnicity may also be associated with significantly worse prognosis, part of which may be explained by lack of access to a major SSc referral center⁹. Our present study also focused on a statewide administrative hospitalization database to determine whether race/ethnicity is associated with in-hospital mortality.

MATERIALS AND METHODS

Design. We used administrative hospitalization data that are available in South Carolina (SC) for research purposes. Statewide analysis permitted a

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more detailed investigation than would have been available at the national level. The SC Office of Research and Statistics (ORS) compiles data from every hospital admission and each emergency room (ER) visit in SC (with the exception of federal and military hospitals), and these data are available to researchers with proposals approved through the ORS data oversight committee. Using patient identifiers (e.g., name, social security number, date of birth, race, sex), ORS links multiple inpatient and/or ER encounters with the same patient by assigning a unique identification number to each patient and including this number on each inpatient and ER record in the datasets provided to researchers. To protect patients' identities, personal information is not available to researchers; however, the unique identification numbers are. Using data provided by ORS, our study addressed whether racial disparities exist among SSc patients in SC with respect to the incidence of in-hospital mortality.

Patient selection. All hospitalizations of patients with SSc occurring in our state from 1996 through 2000 were identified from these databases using ICD-9 codes. The study was approved by the Medical University of South Carolina Institutional Review Board and the ORS Data Oversight Committee. Personal identification numbers were obtained for each of these encounters, and the databases were searched again for all hospital and ER encounters with these patients, regardless of whether a diagnosis of SSc was listed or not. Thus, barring errors in diagnostic coding, any person with SSc who had a hospital or ER encounter in SC during 1996 through 2000 was identified through this process, as were data pertaining to all their hospitalizations.

Data collection. Demographic and socioeconomic data obtained included age, sex, race/ethnicity (non-Hispanic white, non-Hispanic black, and other; hereafter referred to as white, black, and other), county of residence, insurance, and zip code-specific income and education data. Because data were obtained from administrative reporting databases, clinical data such as disease classification (e.g. limited or diffuse cutaneous disease), disease duration, presence of certain antibodies, and SSc-specific organ involvement were not available. However, certain demographic and clinical data and severity of disease indicators were available and served as surrogates for clinical characteristics typically associated with decreased survival. These included age (highly correlated with both disease duration and mortality), discharge status (indicating whether or not the patient died in-hospital), number of hospitalizations during the 5-year study period, transfer status, admission type (emergency, urgent, elective), comorbid conditions, length of stay, diagnostic related groups (DRG), procedure codes, and a facility indicator of whether or not the treatment facility was the Medical University of South Carolina, a major SSc referral center. Comorbid conditions selected for inclusion in the analyses were congestive heart failure, arrhythmia, hypertension, pulmonary hypertension, pulmonary fibrosis, and renal disease. Using the DRG, indicator variables were created to reflect whether the admission was medical or surgical, and whether or not there were significant complications. As a surrogate for diffuse cutaneous disease, procedure codes were used to determine whether or not patients underwent hemodialysis during hospitalization. As an indicator of reason for hospitalization we used codes indicating whether or not gastrointestinal procedures were performed. Other procedure codes (besides hemodialysis) occurred too infrequently or could not be clearly identified as a reason for admission.

Median household income, based upon 2000 US Census estimates and inflated to 2004 dollars using an employment cost index based on estimates provided by the US Bureau of Labor Statistics, was linked to patient data via zip code. Similarly, zip code-specific education level quartiles were created based upon the percentage of residents within a patient's zip code with less than a high school education.

Statistical analysis. Comparisons of demographic and clinical characteristics between white, black, and other patients were performed using t tests, chi-square tests, and Wilcoxon rank-sum tests, as appropriate. The last hospitalization of each patient during this timeframe was used to identify predictors of in-hospital death using multivariable logistic regression. In this logistic regression model, the dependent variable of interest was whether or

not the subject died during the hospitalization, while the key independent variable of interest was the subject's race/ethnicity (white, black, other). Covariates included other patient demographic and clinical characteristics.

RESULTS

A total of 2,574 hospitalizations by 727 unique patients with SSc were identified in the study timeframe, during which 140 deaths (5.4% of hospitalizations, 19.1% of patients) occurred. Summaries of demographic and clinical characteristics including comparisons among the 3 race/ethnicity groups are listed in Tables 1 and 2. White patients were significantly more likely to have private insurance ($p < 0.01$). Black patients were significantly more likely than whites or others to have an admission classified as emergent ($p < 0.05$) and more likely to have a DRG indicating that complications were present during admission ($p < 0.01$). Several significant differences were noted in the prevalence of comorbid conditions, including arrhythmia being more prevalent among whites ($p < 0.01$), hypertension being highest among blacks and others ($p < 0.01$), and pulmonary hypertension and pulmonary fibrosis being highest among other subjects ($p < 0.05$). Despite white patients being older on average than the black and other patients, the crude in-hospital mortality rate for whites (15.7%) was much lower than that for blacks (23.0%) and other subjects (27.7%).

Results of the multivariate logistic regression model are shown in Table 3. Even after adjustment for markers of socioeconomic status, disease severity, comorbidities, and surrogates for disease duration, diffuse cutaneous disease, complications, and reasons for admission, blacks [odds ratio (OR) 1.70, 95% confidence interval (CI) 1.01–2.86] and other non-white subjects (OR 2.06, 95% CI 1.04–4.09) had significantly greater odds of death during their hospitalization compared to whites.

Other patient characteristics associated with increased mortality included being transferred from another hospital, having an admission classified as emergent, longer length of stay, greater numbers of prior hospitalizations, having a diagnosis of heart failure, and not being diagnosed with hypertension. Transfer patients, who typically have more severe complications, had roughly 4-fold increased odds of dying in-hospital compared to non-transfer patients. Patients whose admission was classified as emergent had an almost 2-fold increase in the odds of dying compared to those with non-emergent (elective) admissions. Patients whose length of stay was over 10 days had almost 3-fold increased odds of dying compared to patients whose stay was 1 to 3 days. Patients with more than 1 prior hospitalization during the study timeframe experienced more than a 2-fold increase in their odds of in-hospital mortality. The odds of dying were also increased roughly 2-fold among patients with heart failure compared to patients without. Lastly, patients with a comorbid diagnosis of hypertension exhibited 60% decreased odds of dying compared to patients without a diagnosis of hypertension.

Table 1. Demographic comparisons by race. Results are expressed as percentages.

Characteristic	Whites, n = 427	Blacks, n = 235	Others, n = 65	Total, n = 727
% Female	83.6	79.2	80.0	81.8
Age*, yrs				
0–34	6.8	14.5	4.6	9.1
35–49	15.0	33.6	24.6	21.9
50–64	31.4	31.1	36.9	31.8
65+	46.8	20.9	33.9	37.3
Education*				
Quartile 1 (lowest)	20.8	30.6	26.2	24.5
Quartile 2	20.4	31.5	29.2	24.8
Quartile 3	27.6	22.1	23.1	25.5
Quartile 4 (highest)	31.2	15.7	21.5	25.3
Median household annual income*				
< \$30,000	8.4	15.7	16.9	11.6
\$30,000–\$40,000	31.6	46.0	38.5	36.9
\$40,000–\$50,000	39.8	31.1	27.7	35.9
> \$50,000	20.1	7.2	16.9	15.7
Insurance**				
Private	34.9	26.8	20.0	31.0
Public	62.8	66.8	76.9	65.3
Other	2.3	6.4	3.1	3.7

* $p < 0.0001$; ** $p < 0.01$

Table 2. Clinical comparisons by race. Results are expressed as percentages unless otherwise defined.

Characteristic	Whites, n = 427	Blacks, n = 235	Others, n = 65	Total, n = 727
In-hospital death*	15.7	23.0	27.7	19.1
Transferred from another hospital	3.3	4.3	7.7	4.0
Admission classified as emergent*	47.1	59.2	50.8	51.3
Admission occurred at a major referral center	18.3	16.2	20.0	17.7
Number of prior hospitalizations during time period				
1	34.0	34.0	18.5	32.6
2	19.9	20.0	20.0	19.9
> 2	46.1	46.0	61.5	47.5
Length of stay, days				
1 to 3	40.3	38.7	40.0	40.0
4 to 10	43.3	43.4	46.2	43.6
> 10	16.4	17.9	13.9	16.6
DRG classification				
Medical	70.7	78.3	76.9	73.7
Surgical	29.3	21.7	23.1	26.3
DRG indicating complications present**	48.0	63.0	50.8	53.1
Gastrointestinal procedure performed	14.3	13.2	12.3	13.8
Hemodialysis performed	3.8	4.7	9.2	4.5
Comorbid conditions				
Heart failure	15.5	19.2	16.9	16.8
Arrhythmia**	14.8	7.2	7.7	11.7
Hypertension**	20.6	33.6	32.3	25.9
Pulmonary hypertension*	9.4	8.1	18.5	9.8
Pulmonary fibrosis*	14.8	10.2	24.6	14.2
Renal disease	8.4	12.3	9.2	9.8
Number of comorbid conditions, mean \pm SD	2.5 \pm 1.4	2.6 \pm 1.3	2.6 \pm 1.4	2.5 \pm 1.4

DRG: diagnostic related group. * $p < 0.05$; ** $p < 0.01$.

Table 3. Crude death rates and results of the multivariate logistic regression model examining factors associated with in-hospital mortality. All odds ratios (OR) were based on a logistic regression model that adjusted for all the listed patient characteristics.

Characteristic	Crude Death Rate, %	Adjusted OR	95% CI	Characteristic	Crude Death Rate, %	Adjusted OR	95% CI
Race				Admission occurred at a referral center			
White	15.7	1.00	—	Yes	19.4	1.28	0.67–2.43
Black	23.0	1.70	1.01–2.86	No	19.1	1.00	—
Other	27.7	2.06	1.04–4.09	Number of prior hospitalizations during time period			
Sex				0	9.7	1.00	—
Male	23.5	1.37	0.81–2.31	1	16.6	1.51	0.76–2.99
Female	18.2	1.00	—	> 1	26.7	2.28	1.29–4.03
Age group, yrs				Length of stay, days			
0–34	12.1	1.00	—	1 to 3	14.2	1.00	—
35–49	16.4	1.56	0.59–4.12	4 to 10	16.1	1.06	0.64–1.74
50–64	21.2	2.10	0.82–5.40	> 10	38.8	2.94	1.64–5.27
65+	20.7	2.14	0.79–5.82	DRG classification			
Education				Medical	20.0	1.00	—
Quartile 1 (lowest)	17.4	0.76	0.29–2.00	Surgical	16.8	0.90	0.52–1.55
Quartile 2	22.8	0.87	0.36–2.06	Complications indicated by DRG			
Quartile 3	20.0	1.05	0.52–2.13	Yes	18.9	1.05	0.68–1.62
Quartile 4 (highest)	16.3	1.00	—	No	19.4	1.00	—
Median household annual income				Gastrointestinal procedure performed			
< \$25,000	14.3	0.96	0.27–3.35	Yes	22.0	0.84	0.46–1.54
\$25,000–\$30,000	21.3	1.39	0.52–3.77	No	18.7	1.00	—
\$30,000–\$35,000	19.5	1.21	0.55–2.66	Hemodialysis performed			
> \$35,000	16.7	1.00	—	Yes	42.4	1.14	0.40–3.23
Insurance				No	18.0	1.00	—
Private	14.2	1.00	—	Comorbid conditions			
Public	21.3	1.14	0.65–2.02	Heart failure	34.4	1.79	1.06–3.03
Other	22.2	1.67	0.55–5.08	Arrhythmia	21.2	0.75	0.39–1.46
Transferred from another hospital				Hypertension	10.6	0.41	0.23–0.71
Yes	48.3	4.23	1.72–10.4	Pulmonary hypertension	26.8	1.26	0.64–2.50
No	17.9	1.00	—	Pulmonary fibrosis	26.2	1.41	0.80–2.49
Admission classified as emergent				Renal disease	39.4	1.77	0.82–3.82
Yes	24.4	1.87	1.19–2.95				
No	13.6	1.00	—				

CI: confidence interval, DRG: diagnostic related group.

DISCUSSION

The most significant finding of our study is that black and other minorities with SSc experience greater odds of in-hospital mortality than whites, even after adjusting for markers of socioeconomic status, disease severity, and comorbidity. Our study also quantified the level of increased risk of mortality associated with a number of other sociodemographic and clinical variables among patients with SSc.

Reasons for the disparities are likely complex. It is unclear whether SSc is more severe in blacks and other minorities because of genetic, environmental/cultural, healthcare access or other healthcare system factors, or combinations thereof. One possibility that could explain the differences would be differential quality of primary and referral care received, although no study to date has confirmed this. Studies in other settings and other diseases suggest that blacks may have a more difficult time getting referrals to specialists¹⁰.

Our study has several strengths over earlier studies of

patients with SSc. With the exception of encounters at federal and military hospitals, datasets used in these analyses revealed the extent of SSc hospitalizations and ER visits from 1996 to 2000 in SC, allowing us to study SSc in a relatively large sample. We also examined disparities in hospital mortality among patients with SSc in a way that accounted for differences in education and income.

The scope of the statewide analysis that is this study's strength also included some inherent limitations. Our analyses rely heavily on ICD-9-CM coding of disease, a task largely accomplished by medical coders working in a variety of hospital settings. It is unclear how accurate such diagnoses are, but it is almost certain that errors in disease classification occur. Given that we searched the databases for any hospitalization and ER visit by patients who had ever had a diagnosis of SSc listed in these datasets, it is probably more likely that we made the error of recording patients who did not have SSc than the error of not recording patients who had SSc and were hospitalized or had an ER visit. The low

percentage of patients reportedly treated by a rheumatologist suggests that we may have under-reported the frequency of specialty rheumatology care. This may be indicative of other misclassifications; other clinical variables (i.e. diagnoses, procedures) not directly associated with hospital billing may also have a greater potential for being under-reported in the administrative data files.

Availability of clinical information was also limited. To account for disease duration, disease classification (e.g., limited or diffuse cutaneous disease), and SSc-specific organ involvement, we had to construct surrogate variables. Despite this limited information, the surrogate variables we included in the model should account for much of the variation in in-hospital mortality rates explained by these immeasurable clinical characteristics. For example, analyses of 178 patients with SSc recruited for another study indicate that age is highly correlated with disease duration ($r = 0.87$, $p < 0.0001$)¹¹. Diffuse disease and associated comorbidities increase mortality risk because they are associated with more severe disease. Our model accounts for these associations by using markers of disease severity including sex, age, insurance, education, income, transfer status, emergent admission status, referral status, number of prior hospitalizations during the study time period, length of stay, whether the admission was medical or surgical, whether or not complications were reported, whether a gastrointestinal procedure or hemodialysis was performed, and comorbid diagnoses.

Because there is no standard for the manner in which race is obtained across the many hospitals and ER included in these data, we may have misclassified some patients' race/ethnicity. However, this may not be as pertinent to our results as to others', as an earlier study indicated that self-reported blacks may be less likely than self-reported Asians and self-reported Native Americans to be mislabeled as whites¹². In addition, we cannot address racial disparities that may exist in other specific racial/ethnic groups such as the Hispanic population of SC because of small sample sizes. Tables 1, 2, and 3 do appear to indicate that disparities may exist with respect to patients with SSc who are considered neither black nor white, and in SC, this group consists predominantly of Hispanics.

The finding that hypertension is associated with reduced odds of mortality may seem counterintuitive. However, there are several possible explanations. These data are administrative in nature, and the coding of diagnoses for hospital billing purposes often results in only the most severe conditions being recorded. If an SSc patient's hospitalization includes a diagnosis of hypertension, then it is

likely that he/she did not have any of the more severe conditions such as cardiac, pulmonary, or renal failure. With potent antihypertensive medications available, hypertension in SSc is often responsive to therapy, thus allowing for shorter length of stay and decreased likelihood of death compared with other less responsive complications of SSc that require hospitalization.

Our findings highlight the need to understand why racial/ethnic disparities exist among SSc patients. Future studies that focus on quality of care received prior to hospitalization, or studies that try to uncover a genetic basis for these disparities, are needed to shed more light on these complex phenomena.

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