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ORIGINAL ARTICLE

Predictors of Hospitalization, Length of Stay, and Cost of Care Among Adults With Dermatomyositis in the United States

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Objective. **To determine the prevalence and risk factors for hospitalization with dermatomyositis and assess inpatient burden of dermatomyositis.**

Methods. **Data on 72,651,487 hospitalizations from the 2002–2012 Nationwide Inpatient Sample, a 20% stratified sample of all acute-care hospitalizations in the US, were analyzed. International Classification of Diseases, Ninth Revision, Clinical Modification coding was used to identify hospitalizations with a diagnosis of dermatomyositis.**

Results. **There were 9,687 and 43,188 weighted admissions with a primary or secondary diagnosis of dermatomyositis, respectively. In multivariable logistic regression models with stepwise selection, female sex (logistic regression: adjusted odds ratio 2.05 [95% confidence interval (95% CI) 1.80, 2.34]), nonwhite race (African American: 1.68 [1.57, 1.79]; Hispanic: 2.38 [2.22, 2.55]; Asian: 1.54 [1.32, 1.81]; and multiracial/other: 1.65 [1.45, 1.88]), and multiple chronic conditions (2–5: 2.39 [2.20, 2.60] and ≥6: 2.80 [2.56, 3.07]) were all associated with higher rates of hospitalization for dermatomyositis. The weighted total length of stay (LOS) and inflation-adjusted cost of care for patients with a primary inpatient diagnosis of dermatomyositis was 80,686 days and $168,076,970, with geometric means of 5.38 (95% CI 5.08, 5.71) and $11,682 (95% CI $11,013, $12,392), respectively. LOS and costs of hospitalization were significantly higher in patients with dermatomyositis compared to those without. Notably, race/ethnicity was associated with increased LOS (log-linear regression: adjusted β [95% CI] for African American: 0.14 [0.04, 0.25] and Asian: 0.38 [0.22, 0.55]) and cost of care (Asian: 0.51 [0.36, 0.67]).**

Conclusion. **There is a significant and increasing inpatient burden for dermatomyositis in the US. There appear to be racial differences, as nonwhites have higher prevalence of admission, increased LOS, and cost of care.**

INTRODUCTION

Dermatomyositis is a rare autoimmune disease (21 per 100,000 persons) characterized by variable severity of muscle weakness concurrent with specific cutaneous manifestations (1). Dermatomyositis is a clinically significant cause of morbidity and quality of life impairment (2). Despite treatment, at least one-third of patients still experience mild to severe disability (2). Dermatomyositis has been shown to be associated with higher rates of malignancy (3), infection (4), and cardiovascular disease (5), all of which may result in hospitalization. However, little is known about the inpatient burden of dermatomyositis in the US.

Previous studies have analyzed the costs of specific treatments associated with dermatomyositis (6), evaluated burden by different metrics, e.g., health resource and work loss (7), or measured costs in other countries (8). In addition, most of these other studies have evaluated aggregate burden of inflammatory myopathies (e.g., dermatomyositis and polymyositis) rather than dermatomyositis in isolation. As a result, use of a comprehensive, national inpatient database could help to elucidate the economic burden of dermatomyositis in the US.

Previous studies found racial/ethnic differences in hospitalization rates and outcomes for stroke (9), cardiovascular disease (10), asthma (11), acute respiratory illness (12), and pemphigus (13). We hypothesized that dermatomyositis is also associated with similar racial/ethnic differences, possibly related to lack of insurance coverage and reduced access to specialty care, such as rheumatology and dermatology. In the present study, we analyzed the incidence and predictors of hospitalization, cost of care, and length of stay (LOS) in US patients with dermatomyositis.

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Significance & Innovations

- Dermatomyositis represents a significant and increasing inpatient burden in the US.
- Female sex and summer and spring seasons are associated with higher rates of hospitalization for dermatomyositis.
- There are racial differences among dermatomyositis patients, as some nonwhite races are associated with higher hospitalization rates, longer length of stay, and increased costs of care.

MATERIALS AND METHODS

Data source. The 2002–2012 Nationwide Inpatient Sample (NIS), provided by the Healthcare Cost and Utilization Project (HCUP) from the Agency for Healthcare Research and Quality, was analyzed. Each year of the NIS contains an approximately 20% stratified representative cross-sectional sample of all hospitalizations in the US. Sample weights were created by the NIS that factored the sampling design of hospitals in the US. These sample weights allow for representative estimates of hospital discharges across the whole country. All data were de-identified and no attempts were made to identify any of the individuals in the database. All parties with access to the HCUP were compliant to its formal data use agreement. The study was approved by the institutional review board at Northwestern University.

Identification of dermatomyositis. The databases were searched for a primary and/or secondary diagnosis of dermatomyositis using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code 710.3. The primary diagnosis was defined in the NIS as the condition chiefly responsible for hospital admission. Hospitalization for dermatomyositis was identified by a primary discharge diagnosis of dermatomyositis. A previous study validated the use of the discharge diagnosis code 710.3 in the inpatient setting for the study of dermatomyositis (14). Patients with ICD-9-CM diagnostic codes of 701.0/710.1 (scleroderma), 710.0 (systemic lupus erythematosus), 710.4 (polymyositis), 710.8 (mixed connective tissue disease), and 710.9 (undifferentiated connective tissue disease) were excluded to minimize misclassification. The control group included all hospitalizations without any diagnosis of dermatomyositis, yielding a representative cohort of US hospitalizations.

Data processing and statistics. All data analyses and statistical processes were performed using SAS, version 9.4. Analyses of survey responses were performed using SURVEY procedures. The unit of analysis was an individual hospitalization. Weighted prevalence (95% confidence intervals [95% CIs]) of hospitalization either with a primary or secondary ICD-9-CM code of dermatomyositis was determined. The hospital cost for inpatient care was calculated based on the total charge of the hospitalization and the cost-to-charge ratio estimated by HCUP. All costs were adjusted for inflation to the year 2014, according to the Consumer Price Index from the US Bureau of Labor Statistics (15). Summary statistics were generated for LOS and inflation-adjusted cost of care, including sum, mean, and 95% CI for hospitalizations with a primary, secondary, or no diagnosis of dermatomyositis.

Three different regression models were constructed. Survey logistic regression models were used to determine 1) the predictors of hospitalization for dermatomyositis. The dependent variable was hospitalization with a primary diagnosis of dermatomyositis versus no dermatomyositis. Linear regression models with log-transformed 2) cost of care or 3) LOS as the dependent variables were used to determine the predictors of cost of hospitalization and LOS. Cost of care and LOS were log-transformed because they were not normally distributed. The independent variable was a primary diagnosis of dermatomyositis versus no dermatomyositis. The independent variables included age (18–39, 40–59, 60–79, and ≥80 years); sex (male, female); race/ethnicity (white, African American, Hispanic, Asian, Native American, and multiracial/other); health insurance (Medicare, Medicaid, private, self-pay, no charge/charity, and other); number of chronic conditions (0–1, 2–5, and ≥6); hospital location (metropolitan [≥1 urban cluster of population ≥50,000] >1 million, fringe/metro <1 million, micropolitan [≥1 urban cluster of population 10,000–49,999], not metropolitan or micropolitan, and Northeast, Midwest, South, and West); and an indicator for calendar year (2002–2003, 2004–2005, 2006–2007, 2008–2009, 2010–2011, and 2012). Chronic conditions were defined by HCUP as lasting ≥12 months and meeting 1 or both of the following requirements: 1) places limitations on self-care, independent living, and social interactions, and 2) results in the need for ongoing intervention with medical products, services, and special equipment (16). Chronic condition count was calculated and provided by HCUP. Crude odds ratios (ORs), β coefficients, and 95% CIs were estimated. Multivariate regression models were constructed using stepwise selection ($\alpha = 0.1$) from the abovementioned covariates. Adjusted ORs, beta coefficients, and 95% CIs were estimated. All statistical models included discharge trend weights, sample strata that account for the hospital's census region or division, ownership/control, location/teaching, and bed size, which was provided by NIS and clustering by individual hospital. Complete case analysis was performed. A 2-sided *P* value less than 0.05 was considered statistically significant.

RESULTS

Patient and hospital characteristics. Overall, there were 72,651,487 adult discharges captured in the NIS between the years 2002–2012. A total of 63,152,659 adult discharges remained after exclusion of normal pregnancies and other connective tissue diseases. There were 2,042 and 9,050 admissions with a primary or secondary diagnosis of dermatomyositis (weighted frequencies of 9,687 and 43,188, respectively). The weighted prevalence of primary and secondary hospitalization for dermatomyositis ranged from 29.8 to 38.8 and 115.8 to 192.1 per million patients per year (Figure 1). Hospitalization rates for patients with a primary or secondary diagnosis of dermatomyositis significantly increased after 2003 compared with years 2002–2003

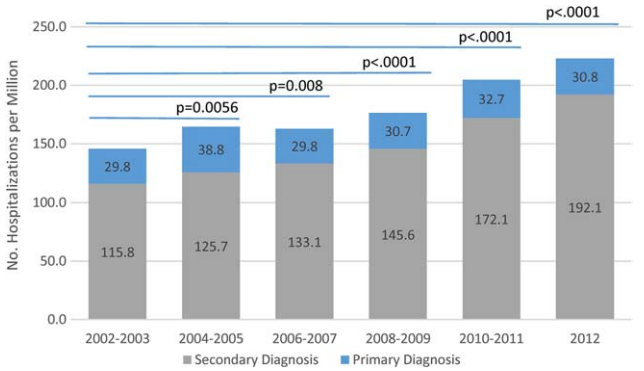

Figure 1. Annual prevalence of hospitalizations for patients with a primary or secondary diagnosis of dermatomyositis (DM). Survey-weighted logistic regression was performed to compare the prevalence of hospitalization for DM over time. Adjusted *P* values are presented for comparisons of years 2004–2005, 2006–2007, 2008–2009, 2010–2011, and 2012 versus 2002–2003. Color figure can be viewed in the online issue, which is available at http://onlinelibrary.wiley.com/doi/10.1002/acr.23190/abstract.

(generalized linear models, $P < 0.05$) (Figure 1). Admissions for dermatomyositis occurred most commonly in the spring (prevalence [95% CI]: 26.26 [24.39, 28.14]) and summer (26.83 [24.84, 28.81]) seasons.

Adult patients with a primary or secondary diagnosis of dermatomyositis were significantly younger than those without such a diagnosis (mean ± SD age 51.7 ± 0.6 years and 59.5 ± 0.3 years versus 61.0 ± 0.1 years). Hospitalizations with a primary diagnosis of dermatomyositis were associated with a younger patient age compared to hospitalizations without a primary diagnosis of dermatomyositis (survey logistic regression; OR [95% CI]: 40–59 years: 0.77 [0.65, 0.91], 60–79 years: 0.45 [0.38, 0.54], and ≥80 years: 0.18 [0.14, 0.23]) (Table 1). Patients who were admitted with dermatomyositis were more likely to be female (2.05 [1.80, 2.34]), African American (2.15 [1.79, 2.57]), Hispanic (2.81 [2.23, 3.54]), Asian (1.54 [1.02, 2.30]), and multiracial/other (1.62 [1.09, 2.40]) compared with whites, more likely to have no charge/charity (1.66 [1.02, 2.73]) compared with private insurance, and more likely to have 2–5 chronic conditions (1.42 [1.13, 1.79]), but less likely to have Medicare (0.46 [0.39, 0.54]) or self-pay (0.73 [0.56, 0.96]) and be in the Midwest (0.69 [0.53, 0.90]) compared to the Northeast. Admissions for dermatomyositis were less likely to occur in hospitals in nonmetropolitan areas (fringe area or metropolitan area with <1 million people: OR 0.79 [95% CI 0.65, 0.95], micropolitan: 0.56 [0.41, 0.76], and not metropolitan or micropolitan: 0.41 [0.29, 0.60]).

In multivariate logistic regression models with stepwise selection, older age, type of insurance coverage, non-Northeast regions, and nonmetropolitan hospital location were all associated with lower rates of admission for dermatomyositis compared to nondermatomyositis, whereas female sex, nonwhite race, and multiple chronic conditions were all associated with higher rates of admission in dermatomyositis compared to nondermatomyositis patients (Table 1).

Reasons for secondary admission. The top 3 primary admission diagnoses for inpatients with a secondary diagnosis of dermatomyositis were (prevalence [95% CI]) pneumonia (rank 1; 4.65% [4.43, 4.87]), rehabilitation procedure (rank 2; 3.23% [3.05, 3.42]), and septicemia (rank 3; 2.78% [2.61, 2.95]) (Table 2). Meanwhile, the top 3 primary admission diagnoses for inpatients without a diagnosis of dermatomyositis were (prevalence [95% CI]) pneumonia (rank 1; 3.06% [3.06, 3.06]), coronary artery disease (rank 2; 2.79% [2.79, 2.80]), and congestive heart failure (rank 3; 2.45% [2.45, 2.45]).

LOS. Patients with dermatomyositis spent a weighted total of 80,686 days and 302,557 days in the hospital for their dermatomyositis or other reasons, respectively. LOS in the hospital was 31% longer for hospitalizations with a secondary diagnosis (geometric mean [95% CI]: 4.61 [4.51, 4.70] days) and 54% longer for hospitalizations with a primary diagnosis (5.38 [5.08, 5.71] days) of dermatomyositis compared with hospitalizations without a diagnosis of dermatomyositis (3.50 [3.48, 3.52]) ($P < 0.0001$ for both). This pattern of prolonged LOS for hospitalizations with dermatomyositis was consistent across all years (Figure 2). Mean LOS decreased between 2002–2012 in patients with no diagnosis and a secondary diagnosis of dermatomyositis, whereas LOS fluctuated in patients with dermatomyositis with a transient increase in 2006–2007 and increasing numbers from 2008 to 2012.

In multivariate weighted linear regression models of log-transformed LOS, increased LOS in patients with a primary diagnosis of dermatomyositis was associated with older age (beta coefficient [95% CI]: 40–59 years: 0.17 [0.06, 0.28]; 60–79 years: 0.24 [0.09, 0.38]; and ≥80 years: 0.50 [0.32, 0.68]), race/ethnicity (African American: 0.14 [0.04, 0.25] and Asian: 0.38 [0.22, 0.55]), and multiple chronic conditions (2–5: 0.43 [0.24, 0.61] and ≥6: 0.75 [0.52, 0.97]) (Table 3). Note that since LOS was log transformed, coefficients from regression models of log-transformed LOS are not the same scale as raw LOS.

Cost of care. The weighted total inflation-adjusted cost of care for hospitalizations with a primary and secondary inpatient diagnosis of dermatomyositis was $168,076,970 and $643,816,887, respectively. The actual total cost is higher as 197 hospitalizations had a missing value for charge and cost. The inflation-adjusted cost of care for hospitalization was 53% higher for hospitalizations with a primary diagnosis (geometric mean [95% CI]: $11,682 [$11,013, $12,392]) and 27% higher for a secondary diagnosis ($9,712 [$9,490, $9,938]) of dermatomyositis than those with no diagnosis of dermatomyositis ($7,620 [$7,539, $7,702]) ($P < 0.0001$for both). This pattern of higher costs for hospitalizations for dermatomyositis was consistent for every year within the cohort.

Mean and total cost of care increased by 16.9% and 33.7%, respectively, in patients without dermatomyositis between 2002 and 2012. In contrast, mean and total costs increased by 37.1% and 72.1%, respectively, in those with a primary diagnosis and 16.7% and 132.2%, respectively, in those with a secondary diagnosis of dermatomyositis.

In multivariate linear regression models of log-transformed cost of care, increased cost of care for hospitalizations with a primary diagnosis of dermatomyositis was associated with race/ethnicity (β [95% CI] for Asian: 0.51 [0.36, 0.67]), region (West: 0.20 [0.07, 0.34]), and multiple chronic conditions (2–5: 0.51 [0.36, 0.66] and ≥6: 0.81 [0.64,

Table 1. Associations of hospitalization with a primary diagnosis of dermatomyositis (DM) in US adults*

Variable	No primary DM diagnosis		Primary diagnosis of DM					
	Weighted frequency	% (95% CI)	Weighted frequency	% (95% CI)	Crude OR (95% CI)	*P*	Adjusted OR (95% CI)	*P*
Age, years								
18–39	46,171,719	15.35 (15.09, 15.60)	2,581	26.65 (23.72, 29.57)	Reference	–	Reference	–
40–59	87,964,433	29.24 (28.99, 29.48)	3,782	39.05 (35.81, 42.29)	0.77 (0.65, 0.91)	0.002	0.69 (0.65, 0.74)	< 0.0001
60–79	108,044,148	35.91 (35.67, 36.15)	2,742	28.31 (25.49, 31.13)	0.45 (0.38, 0.54)	< 0.0001	0.42 (0.39, 0.46)	< 0.0001
≥80	58,701,115	19.51 (19.21, 19.81)	581	6.00 (4.76, 7.24)	0.18 (0.14, 0.23)	< 0.0001	0.16 (0.14, 0.18)	< 0.0001
Sex								
Female	165,018,470	54.91 (54.73, 55.09)	6,891	71.41 (68.71, 74.11)	2.05 (1.80, 2.34)	< 0.0001	2.14 (2.03, 2.25)	< 0.0001
Male	135,492,638	45.09 (44.91, 45.27)	2,759	28.59 (25.89, 31.29)	Reference	–	Reference	–
Race								
White	171,844,604	71.61 (70.50, 72.71)	4,138	52.45 (48.11, 56.80)	Reference	–	Reference	–
African American	33,995,816	14.17 (13.42, 14.91)	1,756	22.56 (19.16, 25.36)	2.15 (1.79, 2.57)	< 0.0001	1.68 (1.57, 1.79)	< 0.0001
Hispanic	21,675,117	9.03 (8.33, 9.74)	1,465	18.57 (14.88, 22.27)	2.81 (2.23, 3.54)	< 0.0001	2.38 (2.22, 2.55)	< 0.0001
Asian	4,602,947	1.92 (1.73, 2.10)	170	2.16 (1.33, 2.98)	1.54 (1.02, 2.30)	0.038	1.54 (1.32, 1.81)	< 0.0001
Native American	1,352,981	0.56 (0.47, 0.66)	69	0.88 (0.21, 1.54)	2.12 (0.99, 4.53)	0.053	1.29 (0.94, 1.77)	0.1197
Other	6,514,923	2.71 (2.43, 3.00)	290	3.68 (2.20, 5.17)	1.85 (1.25, 2.74)	0.002	1.65 (1.45, 1.88)	< 0.0001
Insurance								
Medicare	153,231,714	51.03 (50.55, 51.51)	3,197	33.21 (29.98, 36.44)	0.46 (0.39, 0.54)	< 0.0001	0.70 (0.65, 0.74)	< 0.0001
Medicaid	32,735,668	10.90 (10.53, 11.28)	1,508	15.67 (13.05, 18.28)	1.01 (0.82, 1.25)	0.90	0.72 (0.67, 0.77)	< 0.0001
Private insurance	86,153,467	28.69 (28.22, 29.16)	3,914	40.66 (37.14, 44.18)	Reference	–	Reference	–
Self-pay	16,281,261	5.42 (5.15, 5.70)	542	5.63 (4.19, 7.08)	0.73 (0.56, 0.96)	0.022	0.60 (0.54, 0.67)	< 0.0001
No charge/charity	1,672,489	0.56 (0.40, 0.71)	126	1.31 (0.56, 2.07)	1.66 (1.02, 2.73)	0.043	1.18 (0.95, 1.46)	0.1415
Other	10,195,746	3.40 (3.21, 3.58)	338	3.52 (2.46, 4.57)	0.73 (0.53, 1.01)	0.054	0.74 (0.65, 0.85)	< 0.0001
Chronic conditions, no.								
0–1	43,120,313	14.33 (14.08, 14.59)	1,101	11.36 (8.94, 13.79)	Reference	–	Reference	–
2–5	149,826,599	49.80 (49.48, 50.11)	5,447	56.23 (53.78, 58.69)	1.42 (1.13, 1.79)	0.003	2.39 (2.20, 2.60)	< 0.0001
≥6	107,934,504	35.87 (35.38, 36.36)	3,139	32.40 (29.64, 35.17)	1.14 (0.87, 1.49)	0.34	2.80 (2.56, 3.07)	< 0.0001
Hospital location								
Metropolitan >1 million	80,961,428	31.63 (29.52, 33.74)	3,230	39.22 (34.11, 43.32)	Reference	–	Reference	–
Fringe/metro <1 million	131,862,373	51.52 (49.49, 53.55)	4,138	50.23 (45.26, 55.20)	0.79 (0.65, 0.95)	0.013	0.94 (0.90, 1.00)	0.0357
Micropolitan	26,841,474	10.49 (9.71, 11.26)	601	7.30 (5.33, 9.26)	0.56 (0.41, 0.76)	0.0002	0.67 (0.60, 0.75)	< 0.0001
Not metro- or micropolitan	16,290,215	6.36 (5.98, 6.75)	268	3.26 (2.15, 4.37)	0.41 (0.29, 0.60)	< 0.0001	0.62 (0.53, 0.71)	< 0.0001
Region								
Northeast	61,185,894	20.34 (19.07, 21.60)	2,285	23.59 (18.17, 28.00)	Reference	–	Reference	–
Midwest	70,675,585	23.49 (22.26, 24.72)	1,830	18.89 (15.56, 22.22)	0.69 (0.53, 0.90)	0.0069	0.79 (0.73, 0.86)	< 0.0001
South	115,761,236	38.47 (36.83, 40.12)	3,684	38.03 (33.32, 42.75)	0.85 (0.66, 1.09)	0.21	0.79 (0.74, 0.84)	< 0.0001
West	53,258,701	17.70 (16.58, 18.82)	1,887	19.48 (15.94, 23.03)	0.95 (0.72, 1.25)	0.70	0.85 (0.79, 0.91)	< 0.0001

* Missing data were encountered in 0 (0.0%) for age; 78,104 (0.1%) for sex; 12,799,346 (20.3%) for race/ethnicity; 0 (0.0%) for hospital region; 128,043 (0.2%) for insurance status; and 0 (0.0%) for number of chronic conditions. There were no significant differences of missing values for race/ethnicity between hospitalizations with a primary, secondary, or no diagnosis of DM ($P = 0.19$). 95% CI = 95% confidence interval; OR = odds ratio.

Table 2. Top 10 primary diagnoses of patients admitted with secondary or no diagnosis of dermatomyositis (DM)*

	Secondary diagnosis of DM				No diagnosis of DM			
Rank	ICD-9-CM code	Primary diagnosis	Weighted frequency	Prevalence (95% CI)	ICD-9-CM code	Primary diagnosis	Weighted frequency	Prevalence (95% CI)
1	486	Pneumonia	2,006	4.65% (4.43, 4.87)	486	Pneumonia	9,197,043	3.06% (3.06, 3.06)
2	V57.89	Rehabilitation procedure	1,396	3.23% (3.05, 3.42)	414.01	Coronary artery disease	8,399,157	2.79% (2.79, 2.80)
3	038.9	Septicemia	1,200	2.78% (2.61, 2.95)	428.0	Congestive heart failure	7,362,733	2.45% (2.45, 2.45)
4	428.0	Congestive heart failure	7,805,468	1.81% (1.67, 1.95)	786.59	Chest pain	5,256,999	1.75% (1.75, 1.75)
5	682.6	Cellulitis of leg	6,971,973	1.62% (1.48, 1.75)	491.21	COPD exacerbation	5,213,595	1.73% (1.73, 1.74)
6	518.81	Acute respiratory failure	6,385,067	1.48% (1.35, 1.61)	038.9	Septicemia	4,426,591	1.47% (1.47, 1.47)
7	599.0	Urinary tract infection	5,964,553	1.38% (1.26, 1.50)	410.71	Subendocardial infarction	4,302,903	1.43% (1.43, 1.43)
8	507.0	Food vomit pneumonitis	59,626	1.38% (1.26, 1.50)	V57.89	Rehabilitation procedure	4,251,095	1.41% (1.41, 1.42)
9	515	Postinflammatory pulmonary fibrosis	5,959,891	1.38% (1.26, 1.50)	427.31	Atrial fibrillation	4,170,705	1.39% (1.39, 1.39)
10	414.01	Coronary artery disease	5,595,514	1.30% (1.18, 1.42)	599.0	Urinary tract infection	3,897,626	1.30% (1.29, 1.30)

* ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification; 95% CI = 95% confidence interval; COPD = chronic obstructive pulmonary disease.

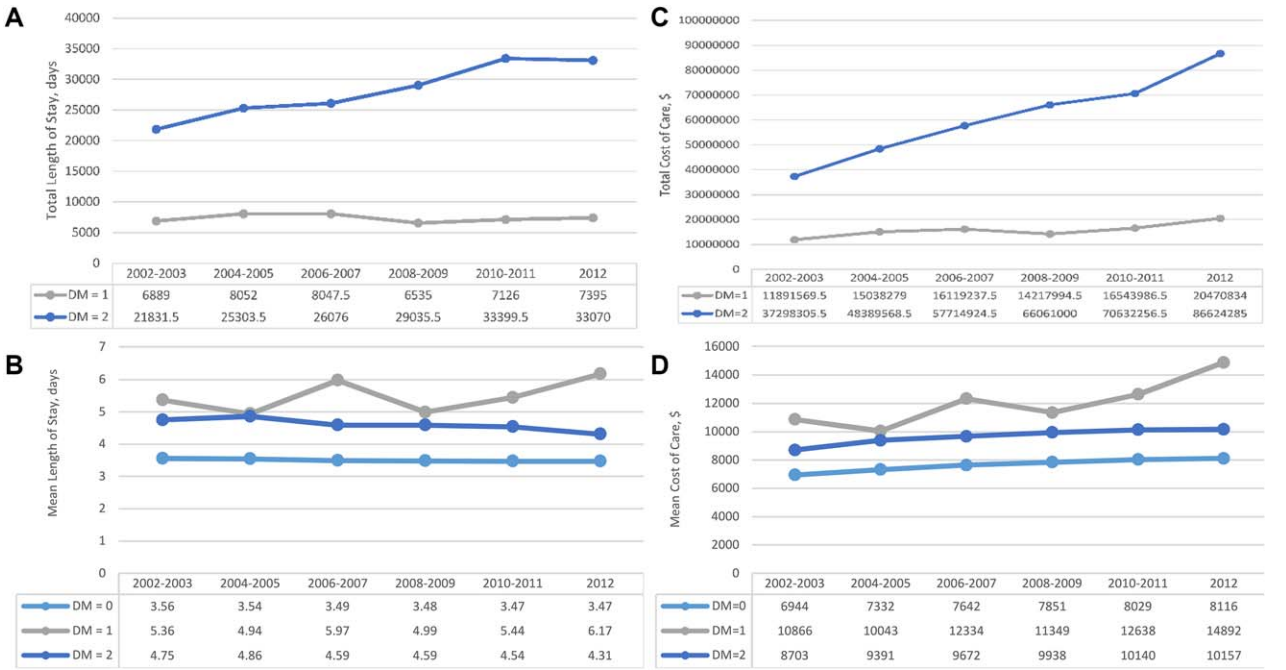

Figure 2. Length of stay and cost of care of hospitalization with a primary or secondary diagnosis for dermatomyositis (DM). Total (**A**) and geometric (**B**) mean length of hospital stay, and total (**C**) and geometric (**D**) mean inflation-adjusted cost of inpatient care are presented for years 2002–2003, 2004–2005, 2006–2007, 2008–2009, 2010–2011, and 2012. DM = 0: no dermatomyositis; DM = 1: primary diagnosis of DM; DM = 2: secondary diagnosis of DM.

0.98]). Note that since cost of care was log transformed, coefficients from regression models of log-transformed costs are not the same scale as raw costs.

DISCUSSION

In the present study, there were significant sex, racial/ethnic, and seasonal differences in hospitalization for dermatomyositis. In particular, higher rates of hospitalization were found in dermatomyositis patients who were female, had nonwhite race/ethnicity (African American, Hispanic, and multiracial/other), and were hospitalized in the spring or summer. Higher rates of hospitalization in females are likely related to their having a higher overall disease prevalence (17). The mean cost and length of hospitalization were significantly higher in patients with a primary or secondary diagnosis of dermatomyositis than those with no dermatomyositis. Hospitalization rates increased between 2002 and 2012 for those with a secondary but not primary diagnosis of dermatomyositis. This suggests that patients with dermatomyositis tended to be sicker overall and were increasingly being hospitalized for comorbidities. Indeed, patients with a secondary diagnosis of dermatomyositis had higher prevalence of pneumonia and septicemia compared to those without dermatomyositis. Individuals with dermatomyositis may be more prone to infection and other comorbidities secondary to immune dysregulation and long-term use of immunosuppressants and corticosteroids. Future studies are needed to assess the causes of increased hospitalizations in patients with a diagnosis of dermatomyositis and develop strategies to reduce hospitalization.

In the present study, we observed differences of hospitalization rates for dermatomyositis by race/ethnicity but not insurance type. These differences are likely multifactorial in nature. It is possible that racial differences in hospitalization are attributable to variations in disease prevalence. However, a study of the US incidence of juvenile dermatomyositis did not find higher rates of disease in African Americans and Hispanics compared to whites (18). There may be differences in disease course and severity between racial/ethnic groups. For example, some racial/ethnic groups may have more severe cutaneous or muscle involvement and multi-organ systemic involvement, e.g., pulmonary and gastrointestinal systems. One study reported specific cutaneous manifestations and higher rates of malignancy in some racial/ethnic groups (19). These differences may impact disease severity and possibly hospitalization rates. There may be delayed diagnosis, i.e., greater duration of untreated disease, among minority patients. That is, they may not be referred for evaluation and management of their dermatomyositis, despite having similar insurance status as whites. Finally, there may be decreased access to specialty care, i.e., rheumatology and dermatology, among racial/ethnic minorities with dermatomyositis. It may be that minority patients have more restrictive specialist physician networks or limited specialty referral coverage, leading to poor disease control. Decreased access to care (20) and worse health outcomes (21) have previously been observed in racial/ethnic minorities. In addition, racial/ethnic differences have been observed in hospitalization rates for other autoimmune and inflammatory disorders, such as pemphigus (13) and psoriasis (22). Future studies are needed to determine how access to outpatient specialty care has affected the rate of hospitalization in patients with chronic diseases.

Table 3. Predictors of length of stay and cost of care for hospitalization with a primary diagnosis of dermatomyositis*

Variable	Length of stay			Cost of care		
	LSM	Adjusted β (95% CI)†	*P*	LSM	Adjusted β (95% CI)†	*P*
Age, years						
18–39	1.43	0 (reference)	–	9.06	0 (reference)	–
40–59	1.60	0.17 (0.06, 0.28)	0.0019	9.09	0.03 (−0.07, 0.13)	0.5955
60–79	1.66	0.24 (0.09, 0.38)	0.0015	9.15	0.09 (−0.03, 0.20)	0.1482
≥80	1.93	0.50 (0.32, 0.68)	< 0.0001	9.19	0.12 (−0.05, 0.29)	0.1566
Sex						
Female	1.63	−0.04 (−0.14, 0.05)	0.3709	9.09	−0.06 (−0.15, 0.03)	0.2131
Male	1.68	0 (reference)	–	9.15	0 (reference)	–
Race						
White	1.65	0 (reference)	–	9.23	0 (reference)	–
African American	1.79	0.14 (0.04, 0.25)	0.0078	9.25	0.03 (−0.08, 0.14)	0.6459
Hispanic	1.63	−0.02 (−0.12, 0.09)	0.7724	9.20	−0.03 (−0.14, 0.08)	0.5772
Asian	2.03	0.38 (0.22, 0.55)	< 0.0001	9.74	0.51 (0.36, 0.67)	< 0.0001
Native American	1.23	−0.42 (−0.67, −0.18)	0.0007	8.11	−1.12 (−1.38, −0.86)	< 0.0001
Other	1.6	−0.05 (−0.30, 0.20)	0.6886	9.21	−0.02 (−0.30, 0.26)	0.8883
Insurance						
Medicare	1.49	−0.18 (−0.29, −0.07)	0.0022	9.07	−0.21 (−0.33, −0.10)	0.0002
Medicaid	1.64	−0.03 (−0.16, 0.10)	0.6277	9.13	−0.16 (−0.29, −0.02)	0.02
Private insurance	1.67	0 (reference)	–	9.28	0 (reference)	–
Self-pay	1.75	0.08 (−0.11, 0.28)	0.3824	9.33	0.05 (−0.13, 0.23)	0.5733
No charge/charity	1.79	0.12 (−0.45, 0.69)	0.6728	8.91	−0.37 (−0.99, 0.25)	0.2374
Other	1.6	−0.07 (−0.21, 0.08)	0.367	9.01	−0.27 (−0.44, −0.10)	0.002
Chronic conditions, no.						
0–1	1.26	0 (reference)	–	8.68	0 (reference)	–
2–5	1.69	0.43 (0.24, 0.61)	< 0.0001	9.19	0.51 (0.36, 0.66)	< 0.0001
≥6	2.01	0.75 (0.52, 0.97)	< 0.0001	9.50	0.81 (0.64, 0.98)	< 0.0001
Hospital location						
Metropolitan >1 million	1.72	0 (reference)	–	9.21	0 (reference)	–
Fringe/metro <1 million	1.68	−0.04 (−0.14, 0.06)	0.4104	9.18	−0.03 (−0.14, 0.07)	0.5371
Micropolitan	1.69	−0.03 (−0.14, 0.07)	0.5484	9.19	−0.02 (−0.16, 0.12)	0.7705
Not metro- or micropolitan	1.53	−0.19 (−0.47, 0.09)	0.1913	8.92	−0.29 (−0.46, −0.13)	0.0005
Region						
Northeast	1.7	0 (reference)	–	9.09	0 (reference)	–
Midwest	1.49	−0.21 (−0.43, 0.02)	0.0691	9.12	0.03 (−0.16, 0.22)	0.7402
South	1.67	−0.03 (−0.16, 0.10)	0.6973	8.98	−0.11 (−0.27, 0.05)	0.1799
West	1.76	0.06 (−0.06, 0.18)	0.2941	9.30	0.20 (0.07, 0.34)	0.0037

* Missing data were encountered in 0 (0.0%) for age; 78,104 (0.1%) for sex; 12,799,346 (20.3%) for race/ethnicity; 0 (0.0%) for hospital region; 128,043 (0.2%) for insurance status; and 0 (0.0%) for number of chronic conditions. There were no significant differences of missing values for race/ethnicity between hospitalizations with a primary, secondary, or no diagnosis of dermatomyositis ($P = 0.19$). LSM = least squares mean; 95% CI = 95% confidence interval.

† Coefficients from regression models of log-transformed length of stay or cost of care should be interpreted with caution as the transformed variables are not the same scale as the raw variables.

Rates of hospitalization for dermatomyositis were highest in the spring and summer, suggesting that ultraviolet light and other environmental exposures may play a role. Dermatomyositis is associated with photosensitivity and exacerbation of cutaneous symptoms with sun exposure (23,24). However, hospitalization rates were still higher in the winter than fall months, suggesting there may be other environmental factors at play, e.g., climate and/or infectious exposures. Future studies are needed to determine the effect of environmental factors on dermatomyositis.

Older age was inversely associated with hospitalization for dermatomyositis. This may be related to the relatively young age at onset and high disease-related mortality. Polymyositis/dermatomyositis patients have previously been reported to have increased mortality compared to the general population (25). However, it is also possible that individuals were first diagnosed with dermatomyositis upon hospitalization around onset of disease. Subsequent hospitalizations in dermatomyositis patients may be due to long-term sequelae of the disease rather than disease exacerbation. This is supported by the higher rates of secondary than primary hospitalization for dermatomyositis at older ages.

Hospitalization with a primary or secondary diagnosis of dermatomyositis contributes to the national inpatient burden, resulting in a 54% and 31% longer LOS, and 53% and 27% higher inpatient costs (approximately $4,000 and $2,000 excess costs per hospitalization) compared to those without dermatomyositis, respectively. The increased costs

are likely due in part to the additional workup required for diagnosis, higher rates of comorbid malignancy (3), infection (4), and cardiovascular disease (5), as well as iatrogenic complications in dermatomyositis patients. However, we were unable to examine specific diagnostic tests and medications used during hospitalization, as these were not recorded within the NIS. Future studies are needed to determine specific contributors to inpatient costs, particularly 1) diagnostic tests ordered and the potential "over testing" for malignancy due to the lack of clear screening guidelines in the current literature, and 2) iatrogenic complications secondary to treatment of dermatomyositis, since long-term corticosteroids are the current standard of care.

Strengths of this study include an analysis of a nationally representative sample of all-payer data over a period of 11 years with more than 72 million records. We previously validated the use of ICD-9-CM codes for identifying dermatomyositis in the inpatient setting (14). Limitations of this study include the inability to distinguish between different subsets of dermatomyositis, including juvenile- versus adult-onset dermatomyositis, as well as patients with hypomyopathic/amyopathic dermatomyositis. In addition, the database did not include data about disease severity. This limited our ability to examine how differences between individual hospitals and patient characteristics might contribute to LOS and costs of care. Moreover, we were unable to determine how many of the hospitalizations were due to readmissions or transfers between hospitals. The cost analysis did not include costs of physician services, out-of-pocket expenses, or outpatient costs. Thus, the total economic burden of dermatomyositis is likely much higher. There was a large frequency of missing data for race/ethnicity in the NIS. However, there were no significant differences of missing values between hospitalizations with a primary, secondary, or no diagnosis of dermatomyositis. While this does not eliminate the concern entirely, it is reassuring that missing values within race/ethnicity are not responsible for the observed associations. Finally, geographic variation was considered by 4 Health Resources and Services Administration regions. Controlling for region did not attenuate the observed racial/ethnic differences. However, future studies using more granular distinctions of geographic location would be useful to further validate these racial differences.

In conclusion, the findings of this study indicate that the inpatient burden of dermatomyositis is extensive. The cost and LOS were consistently higher for patients with dermatomyositis than those without. Sex, nonwhite race, and season were associated with higher rates of hospitalization, with African American and Asian populations having an increased LOS, and Asian populations having an increased cost of care. Future research is needed to identify what proportion of these differences is due to disparity versus biologic differences in disease course.

AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be submitted for publication. Dr. Silverberg had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study conception and design. Kwa, Ardalan, Laumann, Silverberg.
Acquisition of data. Kwa, Ardalan, Laumann, Silverberg.
Analysis and interpretation of data. Kwa, Silverberg.

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