Short running title: Predicting Lupus Rehospitalizations

Title: Age-Stratified Thirty-Day Rehospitalization and Mortality and Predictors of Rehospitalization among Patients with Systemic Lupus Erythematosus: a Medicare cohort study

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ABSTRACT

Objective

Recent studies suggest young adults with lupus have high 30-day readmission rates, which may necessitate tailored readmission reduction strategies. To aid in risk-stratification for future strategies, we measured 30-day rehospitalization and mortality among Medicare beneficiaries with lupus and determined rehospitalization predictors by age.

Methods

In a 2014 20% national Medicare sample of hospitalizations, rehospitalization risk and mortality within 30 days of discharge were calculated for young (18-35), middle-aged (36-64), and older (65+) beneficiaries with and without lupus. Multivariable GEE models were used to predict rehospitalization among lupus patients by age group using patient, hospital, and geographic factors.

Results

Among 1.39 million Medicare hospitalizations, 10,868 involved lupus beneficiaries. Hospitalized young adult lupus beneficiaries were more racially diverse, living in more disadvantaged areas, and had more comorbidities than older lupus and non-lupus beneficiaries. Thirty-day rehospitalization was 36% among young adult lupus beneficiaries – 40% higher than peers without lupus and 85% higher than older (65+) lupus beneficiaries. Longer length of stay and higher comorbidity risk score increased odds of rehospitalization in all age groups, while specific comorbid condition predictors

and their impact varied. Our models, which incorporated neighborhood-level socioeconomic disadvantage, had moderate-to-good predictive value (c-statistics 0.67-0.77), outperforming administrative data models lacking comprehensive social determinants in other conditions.

Conclusions

Young adults with lupus on Medicare had very high 30-day rehospitalization at 36%. Considering socioeconomic disadvantage and comorbidities provided good prediction of rehospitalization risk, particularly in young adults. Young lupus beneficiaries with comorbidities should be a focus of programs aimed at reducing rehospitalizations.

Patients with systemic lupus erythematosus (SLE or lupus) experience high rates of hospital readmission (24-27%) [1,2]. Medicare covers over a third of US lupus hospitalizations [2,3], and more than half of Medicare lupus hospitalizations occur in patients under 65, who qualified for Medicare due to disability or end stage renal disease (ESRD) [2]. In 2012, the Centers for Medicare & Medicaid Services (CMS) implemented a program that financially penalizes hospitals for unplanned readmissions for six conditions as an indicator of poor inpatient care quality [4]. While readmissions related to SLE are not included in the program, rehospitalization within 30 days represents an important care quality marker. We previously reported higher 30-day readmissions in young adults compared to older age groups (27% vs 17%), yet drivers of readmission in young adults remain unclear [2].

Many young adults with SLE were diagnosed before age 18. Making up 20% of lupus cases in the US [5-7], early-onset versus adult-onset patients are more likely to identify as Black, Hispanic, Asian, or American Indian [5,8], have lower socioeconomic status [7], and have greater organ damage [8]. Young adults with lupus also use emergency care more frequently than older SLE patients [9]. Lower socioeconomic status and greater disease activity further increase odds of emergency visits [9]. Disproportionately high acute care use and rehospitalizations might indicate sub-optimal outpatient management, leading to increased healthcare costs and poor outcomes [10,11]. In other conditions, risk-stratification to target high risk patients has helped reduce rehospitalizations and healthcare costs [12-16].

Our first objective was to assess rates of 30-day rehospitalization and mortality in young

adults with SLE compared to non-SLE and older SLE Medicare beneficiaries. Then, to risk stratify, our second objective was to identify predictors of 30-day rehospitalization among young adults with SLE compared to older SLE beneficiaries.

METHODS

Study population

We performed a cohort study utilizing a geo-linked 20% random sample of Medicare beneficiaries. Hospitalizations of adult beneficiaries between January 1st and November 30th, 2014 were eligible for inclusion; a beneficiary could contribute multiple hospitalizations. Inclusion required hospitalization with a lupus diagnosis code (ICD-9-CM 710.0) and discharge before November 30, 2014 (Figure 1). At least 12 months of continuous Medicare A and B coverage with any claims before index hospitalization were required for baseline comorbidity assessment. Beneficiaries lacking at least 30 days of A/B coverage after discharge were excluded unless they died in the 30 days. Due to alternative claims processing, beneficiaries with Health Maintenance Organization plans or Railroad worker benefits were excluded as their Medicare data may be incomplete. Consistent with standard rehospitalization metrics, long-term acute care facility, psychiatric, rehabilitation, cancer, children's hospitals, and drug treatment hospitalizations were excluded [10]. Beneficiaries were excluded from regression analysis if they were missing geographical residence.

This study was approved by the Health Sciences Minimal Risk Institutional Review Board at the University of Wisconsin School of Medicine and Public Health with a waiver of individual informed consent as a secondary analysis of administrative claims data

(study ID: 2020-0438).

SLE definition

Patients were defined as having SLE if the hospitalization was associated with an International Classification of Diseases, Ninth Revision, diagnosis code for SLE (ICD-9 710.0) [specificity of 99.4%] at any diagnosis level [2,17,18].

Outcomes

The primary outcome for this study was all-cause readmission to a hospital setting within thirty days of discharge [19]. All-cause thirty-day mortality (defined using the National Death Index) was evaluated as a secondary outcome.

Predictors

Potential 30-day readmission predictors included both individual and contextual factors to capture broad influences on rehospitalization [11,15,20]: demographic and socioeconomic status (SES) variables, geographic area, comorbidities, and characteristics of the index hospital. Age was measured at index hospitalization. Age groups were young (18-35), middle-aged (36-64), and older adults (65+). Medicare-reported race and ethnicity were included as a proxy for lived experiences of these groups, including structural and institutional racism. For analysis, race and ethnicity responses were consolidated to Asian, Black, American Indian, Hispanic, White, and Other/Unknown using the Research Triangle Institute (RTI) variable [21-24]. Medicaid status [25] was also included. The Area Deprivation Index (ADI) rank score was used to capture neighborhood-level socioeconomic disadvantage based on nine-digit ZIP code [26,27]. The ADI includes 17 variables, reflecting census block-level income, education,

employment, and housing quality. To account for geographical context, patients were classified into isolated, small rural, large rural, and urban areas based on Rural-Urban Commuting Area (RUCA) codes by ZIP code [28,29].

The following health status variables were included: disability status, CMS's hierarchical condition category community risk score (HCC) [30], Elixhauser Comorbidity Index conditions [31], and length of the index hospital stay. Disability was determined by original qualification for Medicare due to disability, regardless of subsequent eligibility (i.e., ESRD, age 65) [25]. The length of stay for the index hospitalization was included as a proxy for medical complexity.

Characteristics of the index treating hospital were evaluated, including affiliation with a medical school, tertile of discharge volume, and critical access hospital status.

Analysis

Descriptive summaries of patient and hospital characteristics for hospitalizations of beneficiaries with SLE and without SLE by age group are provided. The non-SLE group was composed of hospitalizations that were not associated with a SLE diagnosis code from the 20% random Medicare sample in the same period. This non-SLE group was used for comparison of observed 30-day rehospitalization and mortality risk but was not used in rehospitalization prediction models.

Observed risk of 30-day rehospitalization and 30-day mortality

Rehospitalization and mortality risk within 30 days of index hospitalization discharge with Clopper-Pearson 95% confidence intervals were calculated by age group among

SLE and non-SLE hospitalizations.

Predictors of 30-day rehospitalization among SLE hospitalizations by beneficiary age group

We used generalized estimating equation (GEE) models with logistic link functions to predict 30-day odds of rehospitalization, clustering by beneficiary to account for multiple hospitalizations. *A priori* variables were selected based on the literature for their association with acute care use among SLE patients; these variables were age, sex, race and ethnicity, disability, length of stay, ADI national rank, HCC community risk score, and renal failure status [2,9,18,32-35]. Other potential predictors, based on theoretical models of rehospitalization, were eligible for selection by LASSO, which maximizes a model's predictive power while minimizing factors in the model for higher efficiency [36].

Two modeling approaches were used. In the first, LASSO variable selection was performed across all SLE associated hospitalizations, regardless of beneficiary age. These selected predictors, along with the *a priori* variables, were combined into one model to predict 30-day rehospitalization and applied separately to young, middle-aged, and older SLE patient groups. This approach allows for quantitative comparisons of odds ratios across age groups. In the second approach, 30-day rehospitalization predictors were selected separately within each beneficiary age group and then combined with the *a priori* variables, resulting in a unique set of predictors (and model) for each age group. This approach allows for a qualitative comparison of relevant predictors between SLE patient age groups. Model performance was assessed by c-statistic.

Sensitivity analysis for obstetrical hospitalizations

Given the age and female predominance of the cohort, sensitivity analyses were performed to determine whether obstetrics-related hospitalizations influenced the findings. First, 30-day rehospitalization rates were calculated and compared for obstetrics-related index hospitalizations, based on having a primary Clinical Classification Software diagnostic code of 11.* (excluding 11.1.* - contraceptive care), and non-obstetrical hospitalizations among SLE and non-SLE beneficiary hospitalizations. Second, LASSO variable selection and GEE models on the SLE cohort were re-performed excluding obstetrical hospitalizations. LASSO-selected variables and significant predictors of rehospitalization were compared for models including and excluding obstetrics-related hospitalizations.

Analysis was conducted using SAS version 9.4 (SAS Institute, Cary, NC).

RESULTS

There were 10,868 SLE associated Medicare hospitalizations in the sample (Figure 1). Beneficiaries with SLE were significantly younger and more likely to be Black or Hispanic than beneficiaries without SLE (Table 1). Disability, receipt of Medicaid, and multiple comorbid conditions were more frequent among young adults with SLE than among older adults with SLE or among the age matched non-SLE Medicare population. Young adults with SLE tended to have a higher illness burden, as measured by HCC, and to live in more disadvantaged neighborhoods relative to both older SLE beneficiaries and those without SLE.

Observed 30-day rehospitalization and mortality risk

Unadjusted 30-day rehospitalization risk was highest in young adult Medicare beneficiaries. In young adults, rehospitalization risk was 10% higher among SLE beneficiaries compared to non-SLE beneficiaries (36% vs. 26%; p<.001). Adults 65+ with SLE had a rehospitalization risk of 20% (Figure 2A). Thus, the rehospitalization risk for young adults with SLE was 40% higher than their peers and 85% higher than the risk for older adults with SLE.

The unadjusted 30-day mortality risk for young adults with and without SLE was similar at 0.5% and 0.7% (Figure 2B). Mortality risk increased with age in SLE and non-SLE beneficiaries, but was statistically lower for those with SLE compared to beneficiaries without SLE in the middle-aged and older age groups.

Rehospitalization predictors across all ages

When examining predictors across all ages of SLE beneficiaries, the variables selected by the LASSO procedure, after accounting for *a priori* variables, were all comorbid conditions: coagulopathy, congestive heart failure, drug use disorder, fluid and electrolyte disorders, and paralysis (Table 2).

When this model was applied separately to each SLE age group, length of index hospitalization and HCC risk score were significant predictors of rehospitalization in all ages. Longer index hospitalization showed a similar increase in odds in each age group (aOR ~1.03). Higher HCC risk scores were associated with higher odds of rehospitalization, with greater impact on middle-aged and older adults (young adult aOR 1.10, 95% CI 1.03, 1.18; middle-aged 1.18, 1.14-1.23; older adults 1.21, 1.17-1.26).

Within the young and middle-aged adult strata, but not among older adults, younger beneficiaries were at higher risk of rehospitalization. Each additional year of age was associated with a 6.4% decrease in odds of rehospitalization among young adults and a 2.1% decrease among middle-aged adults.

In young adults, fluid and electrolyte disorders (aOR 2.35; 95% CI 1.53, 3.61), congestive heart failure (2.05; 1.44, 2.91), drug use disorder (1.58; 1.10, 2.27), and coagulopathy (1.46; 1.03, 2.06) substantially increased the odds of rehospitalization. Paralysis was associated with lower rehospitalization odds (0.23; 0.07, 0.78). The impact of these comorbid conditions generally decreased in the older age groups. In middle-aged adults, only drug use disorder (1.73; 1.31, 2.27) and fluid and electrolyte disorders (1.26; 1.05, 1.52) remained significant. Among older adults, congestive heart failure (1.32; 1.08, 1.61) was the only significant predictor beyond length of stay and HCC risk score.

The c-statistic for the model was 0.766 for young adults, 0.703 in middle-aged adults, and 0.673 in older adults.

Age-specific rehospitalization predictors

With the sample restricted to young adults with SLE, more variables were added by the LASSO procedure as predictors and included index hospital characteristics (index hospital medical school affiliation and discharge volume) and additional comorbid condition indicators (deficiency anemia, diabetes, hypertension with complications, and valvular disease) (Table 3). With the addition of more comorbid condition variables, coagulopathy became non-significant (1.36; 0.97, 1.90), while valvular disease was

associated with increased odds (1.74; 1.14, 2.65). Index hospitalization at a medical school affiliated hospital was significantly protective for rehospitalization (0.68; 0.50, 0.92).

When LASSO variable selection was performed among middle-aged beneficiaries with SLE, additional variables selected as predictors included critical access status of the index hospital along with alcohol use disorder, liver disease, pulmonary circulation disorders, and weight loss (Table 3). Coagulopathy, congestive heart failure, and paralysis were no longer selected for the model. Drug use disorder (1.67; 1.23, 2.18) and liver disease (1.32; 1.03, 1.68) conferred additional risk for rehospitalization, while hospitalization in a critical access hospital (0.30; 0.10, 0.95) and weight loss (0.71; 0.55, 0.92) were associated with decreased odds.

Among older adults with SLE, only three variables were selected as predictors by the LASSO procedure: congestive heart failure, other neurological conditions, and paralysis. Congestive heart failure (1.35; 1.11, 1.64) and other neurological conditions (1.26; 1.01, 1.58) were significantly associated with increased odds of rehospitalization, while paralysis trended towards decreased odds (0.58; 0.33, 1.00).

The c-statistic for the young adult model was 0.775, 0.706 for the middle-aged adult model, and 0.672 for the older adults model.

Sensitivity analysis for obstetrical hospitalizations

Obstetrics-related hospitalizations made up 0.52% of SLE-related hospitalizations compared to 0.19% of non-SLE hospitalizations. While rehospitalization rates were

much lower for obstetric hospitalizations among young adults without SLE (9.8% vs 27.6% in non-obstetric; p<0.0001), rehospitalization rates for obstetric and non-obstetric hospitalizations among young adults with SLE were similarly high (31.7% vs 36.5%; p=0.53). When obstetric hospitalizations were excluded, rehospitalization rates showed very minimal change and there were no changes in the significant predictors of rehospitalization.

DISCUSSION

In this study, we found the 30-day rehospitalization risk among young adult Medicare beneficiaries with SLE to be 36%; 40% higher than young adult beneficiaries without SLE, and 85% higher than SLE beneficiaries 65 or older. Young adult beneficiaries with SLE were more racially diverse, from more disadvantaged neighborhoods, and had a higher burden of comorbidities than middle-aged and older adult SLE beneficiaries. Our models had moderate-to-good predictive ability for 30-day rehospitalization among SLE beneficiaries using geo-linked administrative data, demonstrating value for risk-stratification. Medical school affiliation of the index hospital was protective for readmissions among young adults with lupus in this Medicare sample. This may indicate positive effects of programs or policies at medical school affiliated hospitals and potential for wider dissemination efforts. To our knowledge, this is among the first studies to evaluate readmissions for young adults with lupus. It adds to findings from multi-payor SLE cohorts that have reported associations of younger age with greater Emergency Department use [9] and direct healthcare costs [37]. Our findings underscore the high rehospitalization risk among young adult Medicare beneficiaries with SLE and

suggest the need to include young adults with SLE in targeted efforts to reduce rehospitalization.

In Kangovi and Grande's framework for readmissions, rehospitalization is not only a result of inpatient care quality and patient health status, but also outpatient care quality, access to care, and patient socioeconomic resources [11]. Uniquely, our models incorporated rich information on the social determinants of health: patient's neighborhood disadvantage (comprised of 17 indicators of socioeconomic resources), Medicaid status, and rurality. We found that the highest risk group, young adult beneficiaries with SLE, lived in more disadvantaged socioeconomic contexts, with a median neighborhood disadvantage index 16 percentile points higher than the U.S. median, and 91% qualified for Medicaid. Young adult Medicare beneficiaries with SLE were also highly diverse at 52% Black and 15% Hispanic. Lower access to care for Black and Hispanic Americans compared to White Americans is well documented, and prior research has shown these groups may also receive lower quality lupus care [38,39].

An inverse relationship between age and rehospitalization rates has been observed in other early-onset chronic conditions, such as Type 1 Diabetes [40]. Young adults with SLE may disproportionately experience additional barriers to outpatient services (e.g., childcare, transportation), potentially contributing to their higher rates of rehospitalization. In the general population, those aged 18-39 were 10% more likely than adults 55 or older to report non-financial barriers leading to delayed or unmet care [41].

To obtain Medicare coverage individuals under age 65 must have end stage renal

disease or have qualified for Social Security disability benefits [42] for ≥24 months.. The five-step qualification process begins by confirming income <$1,070/month. Young adults with SLE additionally had higher prevalence of many significant comorbid conditions than any other SLE age group (Table 1). In addition to HCC risk score and renal failure status, several other comorbidities potentially related to SLE pathophysiology (coagulopathy, congestive heart failure, fluid and electrolyte disorders, and paralysis) were selected for model inclusion. Notably, renal failure was not associated with odds of rehospitalization. Fluid and electrolyte disorders may have captured the sequalae of renal failure that predict rehospitalization. While obstetrical hospitalizations had significantly lower rehospitalization rates among beneficiaries without SLE, obstetrical hospitalizations of lupus beneficiaries still had high levels of rehospitalization. This suggests readmission reduction efforts should extend to obstetrical care for patients with lupus.

Among young and middle-aged adults, drug use disorder was associated with increased rehospitalization odds. Patients with lupus often need chronic pain management as part of their SLE treatment and are 2 to 3 times more likely to be taking prescribed opioids than non-SLE patients, with greater prevalence of previous opioid-related encounters among young adults with lupus [43,44]. Thus, these findings raise concerns about the contribution of substance use disorders, particularly in relation to prescribed opioids, to rehospitalization.

Among young adults with SLE, index hospitalization at a medical school-affiliated hospital was associated with lower odds of rehospitalization. This aligns with previous

literature showing higher quality of care and lower 30-day post-discharge mortality for major teaching hospitals compared to non-academic hospitals for many common inpatient conditions [45,46]. Our finding prompts interest in identifying practices at academic centers that may reduce rehospitalization for potential dissemination.

Our models outperformed prior U.S. population-based studies on health condition-specific readmission risk prediction using retrospective administrative data which reported moderately predictive models (c-statistic range of 0.55 to 0.65) [15]. Our method, combining *a priori* and LASSO-selected variables including a neighborhood-level social determinants of health index, performed better (c-statistic range of 0.67 to 0.77) than those in the literature. These results suggest the value of incorporating location-based metrics of SES, such as the ADI, in readmission risk prediction models. Such metrics are now freely accessible and can be integrated into both retrospective administrative and real-time electronic health record data [27,47]. Notably, while the fitting of age-specific models revealed some unique significant predictors in each age group, it had little effect on overall predictive value compared to the model developed with patients of all ages. The presented lupus-specific prediction models can aid healthcare and insurance systems in deciding where to focus resources to reduce rehospitalizations by risk-stratifying among the high-risk SLE patient population.

While there are many strengths of this study, including a large national cohort of lupus patients, we acknowledge some limitations. Since this study utilized claims data, we do not have some patient health measures such as functional status or current SLE disease activity. Individuals must meet additional requirements to receive Medicare

benefits under age 65. Thus, results under age 65 may not generalize to the US lupus population, particularly patients with better health status, lower prevalence of ESRD, or those unable to navigate disability qualification. However, one-third of individuals with SLE in the U.S. have public insurance and one-half of SLE-related hospitalizations and Emergency Department visits are covered by Medicare or Medicaid [10,48,49], making this cohort relevant to practice and policy. Higher rates of ED use among young adult lupus patients in a multi-payor lupus cohort [9] suggest that the higher risk of acute healthcare use in young adult lupus patients is not unique to Medicare beneficiaries. Poor health status of Medicare beneficiaries also underscores the importance of developing interventions for this group. Reported race and ethnicity in Medicare data have known issues with misclassification [22,23]. While we used the more valid RTI measure, approximately 4% of patients may be misclassified. Native American and Asian patients are more likely to be misclassified [22], which could affect comparisons involving these groups. As administrative data were used in this study, conditions and billing codes may not have been uniformly coded for all beneficiaries. However, previously validated, published algorithms for administrative data were used to define SLE and other comorbidities [18,31]. Coding bias may also have been reduced since all individuals in the cohort had the same insurance coverage.

While Medicare covers many lupus patients with SLE, multi-payor or Medicaid cohorts should be evaluated to compare rates and validate the rehospitalization predictors among young adults, including more patients without ESRD. Further research comparing rehospitalization reasons should be performed among young adults with SLE. Additional evaluations are needed of socioeconomic resource and access barriers

for young adults with SLE and their relation to rehospitalization, ambulatory versus acute care use, and healthcare costs. For Medicare lupus-related hospitalizations, the administrative data-based predictive models had moderate-to-good predictive value and could be applied to prioritize lupus patients for readmission interventions. These areas of inquiry can be leveraged to inform program and policy development to reduce rehospitalization and improve care for young adults with SLE.

Young adult Medicare beneficiaries with SLE were 40% more likely to be rehospitalized within 30 days compared to age matched non-SLE beneficiaries and 85% more likely than older SLE beneficiaries. This elevated rehospitalization rate among young adults with SLE in Medicare may be partially explained by higher neighborhood disadvantage and greater prevalence among Black and Hispanic patients, who generally have lower access to healthcare and receive lower quality lupus care than White patients [38,39]. Young adult beneficiaries with SLE also had more comorbidities which increased their odds of rehospitalization. The presented lupus-specific prediction models had moderate-to-good prediction for 30-day rehospitalization, informing risk-stratification. Together, these findings suggest a critical need to develop targeted interventions, alongside young adults with SLE, to provide greater outpatient support, address disease management barriers, and reduce costly rehospitalizations.

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FIGURE LEGENDS

Figure 1. Flow diagram describing creation of study cohorts from a 20% national Medicare sample of index hospitalizations between January 1, 2014 and November 30, 2014.

Figure 2. Observed 30-day rehospitalization rates (panel A) and mortality rates (panel B) among SLE (black) and non-SLE (grey) Medicare beneficiaries by age category. Error bars represent 95% confidence intervals.

TABLE 1

Table 1. Characteristics of Hospitalizations of Medicare Beneficiaries

Patient Characteristic n (%)		Non-SLE n= 1,378,654	SLE Age 18-35 n= 1,133	SLE Age 36-64 n= 4,855	SLE Age 65+ n= 4,880
Female Sex		776,803 (56)	1,037 (92)	4,331 (89)	4,355 (89)
Age (median, IQR)		75.0, 67.2-83.2	29.8, 26.8-32.5	52.5, 45.4-59.0	73.4, 69.3-79.7
Race/Ethnicity	Asian	14,920 (1)	24 (2)	52 (1)	37 (1)
	Black	168,877 (12)	586 (52)	1,880 (39)	687 (14)
	Hispanic	27,180 (2)	170 (15)	297 (6)	71 (1)
	American Indian	10,068 (1)	26 (2)	64 (1)	39 (1)
	White	1,378,654 (83)	253 (22)	2,493 (51)	3,992 (82)
	Other/Unknown	19,022 (1)	74 (7)	69 (1)	54 (1)
ADI National Rank (median, IQR)		51, 28-74	66, 42-86	63, 39-83	50, 26-72
Medical School Affiliated Hospital		709,740 (52)	734 (65)	2,809 (58)	2,424 (50)
Critical Access Hospital		45,383 (3)	*	51 (1)	104 (2)
Discharge Volume:	Highest Tertile	467,995 (34)	450 (40)	2,023 (42)	1,744 (36)
	Middle Tertile	454,667 (33)	427 (38)	1,614 (33)	1,701 (35)
	Lowest Tertile	455,992 (33)	256 (23)	1,218 (25)	1,435 (29)
Ever Received Medicaid		411,694 (30)	1,036 (91)	2,912 (60)	1,059 (22)
Disability on Enrollment		440,957 (32)	898 (79)	4,590 (95)	1,559 (32)
Length of Stay (median days, IQR)		4, 2-6	4, 2-6	4, 2-6	4, 2-6
HCC Risk Score (median, IQR)		2.27, 1.26-3.89	3.92, 2.24-6.07	3.25, 1.90-5.32	2.8, 1.70-4.42
Renal Failure		308,476 (22)	745 (66)	1,839 (38)	1,244 (25)
Coagulopathy		94,073 (7)	363 (32)	830 (17)	488 (10)
Congestive Heart Failure		291,295 (21)	345 (30)	1,139 (23)	1,134 (23)
Deficiency Anemia		429,475 (31)	900 (79)	2,547 (52)	1,917 (39)
Fluid and Electrolyte Disorders		406,930 (30)	794 (70)	2,234 (46)	1,674 (34)
Hypertension with Complications		983,804 (71)	895 (79)	3,566 (73)	3,601 (74)
Other Neurological Disorder		223,999 (16)	338 (30)	1,104 (23)	823 (17)
Paralysis		50,851 (4)	23 (2)	196 (4)	124 (3)
Pulmonary Circulation Disorder		79,098 (6)	209 (18)	605 (12)	446 (9)
Valvular Disease		159,653 (12)	145 (13)	629 (13)	678 (14)
Alcohol Use Disorder		49,741 (4)	36 (3)	164 (3)	22 (0)
Diabetes		495,115 (36)	209 (18)	1,651 (34)	1,403 (29)
Drug Use Disorder		55,168 (4)	308 (27)	630 (13)	78 (2)
Liver Disease		64,096 (5)	75 (7)	441 (9)	227 (5)
Weight Loss		106,444 (8)	210 (19)	572 (12)	436 (9)

*Suppressed due to small cell size. ADI = Area Deprivation Index. HCC Risk Score = Hierarchical condition category community risk score.

TABLE 2

Table 2. Odds Ratios for 30-Day Rehospitalization across SLE Age Strata with LASSO Selected Predictors from all SLE Beneficiaries

		SLE Age 18-35 n= 1,103	SLE Age 36-64 n= 4,748	SLE Age 65+ n= 4,789
Age at Index Admission (per year)		**0.94 (0.90, 0.98)**	**0.98 (0.97, 0.99)**	0.99 (0.98, 1.01)
Sex	Female	1.16 (0.70, 1.93)	0.90 (0.69, 1.17)	0.887 (0.68, 1.16)
Race/Ethnicity	White	ref	ref	ref
	Asian	0.42 (0.16, 1.12)	0.75 (0.35, 1.57)	0.81 (0.37, 1.78)
	Black	0.79 (0.52, 1.20)	1.13 (0.94, 1.36)	1.07 (0.85, 1.35)
	Hispanic	0.61 (0.36, 1.01)	0.98 (0.71, 1.36)	0.83 (0.41, 1.70)
	American Indian	1.07 (0.48, 2.36)	1.31 (0.76, 2.26)	1.02 (0.55, 1.92)
	Other/Unknown	0.89 (0.47, 1.67)	0.67 (0.35, 1.25)	1.17 (0.56, 2.46)
Ever received Medicaid		1.00 (0.58, 1.73)	0.93 (0.78, 1.11)	0.98 (0.79, 1.22)
ADI National Rank (per decile increase)		1.00 (0.95, 1.06)	1.02 (0.99, 1.05)	0.98 (0.95, 1.01)
Disability on Enrollment		0.93 (0.61, 1.42)	0.94 (0.67, 1.31)	0.98 (0.82, 1.18)
Length of Stay (per day)		**1.04 (1.02, 1.06)**	**1.04 (1.02, 1.05)**	**1.03 (1.01, 1.04)**
HCC Community Risk Score (per unit)		**1.10 (1.03, 1.18)**	**1.18 (1.14, 1.23)**	**1.21 (1.17, 1.26)**
Renal Failure		1.08 (0.74, 1.58)	1.09 (0.89, 1.34)	1.01 (0.84, 1.23)
Coagulopathy		**1.46 (1.03, 2.06)**	1.09 (0.87, 1.37)	1.15 (0.91, 1.45)
Congestive Heart Failure		**2.05 (1.44, 2.91)**	1.15 (0.93, 1.42)	**1.32 (1.08, 1.61)**
Fluid and Electrolyte Disorders		**2.35 (1.53, 3.61)**	**1.26 (1.05, 1.52)**	1.17 (0.97, 1.41)
Paralysis		**0.23 (0.07, 0.78)**	0.75 (0.49, 1.15)	0.61 (0.37, 1.02)
Drug Use Disorder		**1.58 (1.10, 2.27)**	**1.73 (1.31, 2.27)**	1.25 (0.75, 2.06)
C-statistic		0.766	0.703	0.673

Variables below the horizontal line were selected by LASSO variable selection performed on all participants with SLE. ADI = Area Deprivation Index with higher values indicating greater disadvantage. HCC = Hierarchical condition category community risk score is scaled to 1 for average risk with higher values indicating greater comorbidities and healthcare utilization.

TABLE 3

Table 3. Odds Ratios for 30-Day Rehospitalization across SLE Age Groups using Age Strata-Specific LASSO Selected Predictors

		SLE Age 18-35 n= 1,103	SLE Age 36-64 n= 4,748	SLE Age 65+ n= 4,789
Age at Index Admission (per year)		**0.93 (0.90, 0.96)**	**0.98 (0.97, 0.99)**	1.00 (0.98, 1.01)
Sex	Female	1.13 (0.68, 1.89)	0.93 (0.72, 1.19)	0.89 (0.68, 1.17)
Race/Ethnicity	White	ref	ref	ref
	Asian	**0.29 (0.10, 0.81)**	0.76 (0.36, 1.59)	0.86 (0.40, 1.86)
	Black	0.72 (0.48, 1.08)	1.13 (0.94, 1.35)	1.08 (0.85, 1.36)
	Hispanic	0.61 (0.36, 1.03)	1.01 (0.72, 1.40)	0.87 (0.43, 1.75)
	American Indian	1.08 (0.52, 2.22)	1.19 (0.71, 2.02)	1.02 (0.53, 1.94)
	Other/Unknown	0.87 (0.46, 1.65)	0.67 (0.26, 1.23)	1.19 (0.57, 2.51)
Ever received Medicaid		0.88 (0.50, 1.54)	0.93 (0.78, 1.11)	0.98 (0.79, 1.21)
ADI National Rank (per decile increase)		1.00 (0.95, 1.05)	1.02 (0.99, 1.05)	0.98 (0.95, 1.01)
Disability on Enrollment		1.00 (0.69, 1.46)	0.92 (0.66, 1.29)	0.98 (0.81, 1.18)
Length of Stay (per day)		**1.03 (1.01, 1.05)**	**1.04 (1.02, 1.05)**	**1.03 (1.01, 1.04)**
HCC Community Risk Score (per unit)		**1.09 (1.02, 1.17)**	**1.19 (1.15, 1.23)**	**1.22 (1.18, 1.27)**
Renal Failure		1.00 (0.69, 1.44)	1.15 (0.95, 1.39)	1.03 (0.85, 1.24)
Medical School Affiliated Hospital		**0.68 (0.50, 0.92)**	-	-
Discharge Volume:	Highest Tertile	ref	-	-
	Middle Tertile	0.73 (0.47, 1.13)	-	-
	Lowest Tertile	0.95 (0.67, 1.36)	-	-
Critical Access Hospital		-	**0.30 (0.10, 0.95)**	-
Deficiency Anemia		1.26 (0.76, 2.10)	-	-
Congestive Heart Failure		**2.02 (1.46, 2.81)**	-	**1.35 (1.11, 1.64)**
Coagulopathy		1.36 (0.97, 1.90)	-	-
Hypertension with Complications		1.05 (0.65, 1.68)	-	-
Fluid and Electrolyte Disorders		**2.30 (1.49, 3.56)**	**1.29 (1.07, 1.55)**	-
Other Neurological Conditions		-	-	**1.26 (1.01, 1.58)**
Paralysis		**0.20 (0.06, 0.63)**	-	0.58 (0.33, 1.00)
Pulmonary Circulation Disorders		-	1.27 (0.98, 1.63)	-
Valvular Disease		**1.74 (1.14, 2.65)**	-	-
Alcohol Use Disorder		-	1.51 (0.97, 2.36)	-
Diabetes		1.37 (0.94, 1.99)	-	-
Drug Use Disorder		**1.57 (1.12, 2.21)**	**1.67 (1.23, 2.18)**	-
Liver Disease		-	**1.32 (1.03, 1.68)**	-
Weight Loss		-	**0.71 (0.55, 0.92)**	-
C-statistic		0.775	0.706	0.672

Variables below the horizontal line were selected by LASSO variable selection procedure performed on the respective age stratum of beneficiaries with SLE. ADI = Area Deprivation Index with higher values indicating greater disadvantage. HCC = Hierarchical condition category community risk score is scaled to 1 for average risk with higher values indicating greater comorbidities and healthcare utilization.

FIGURE 1

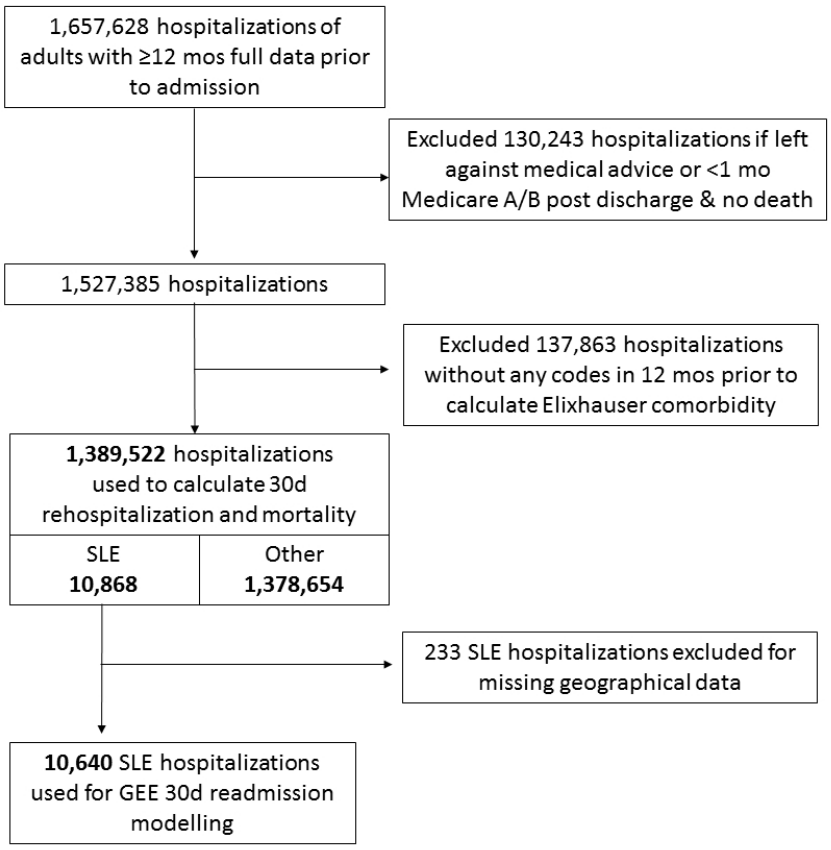

Figure 1. Flow diagram describing creation of study cohorts from a 20% national Medicare sample of index hospitalizations between January 1, 2014 and November 30, 2014.

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FIGURE 2

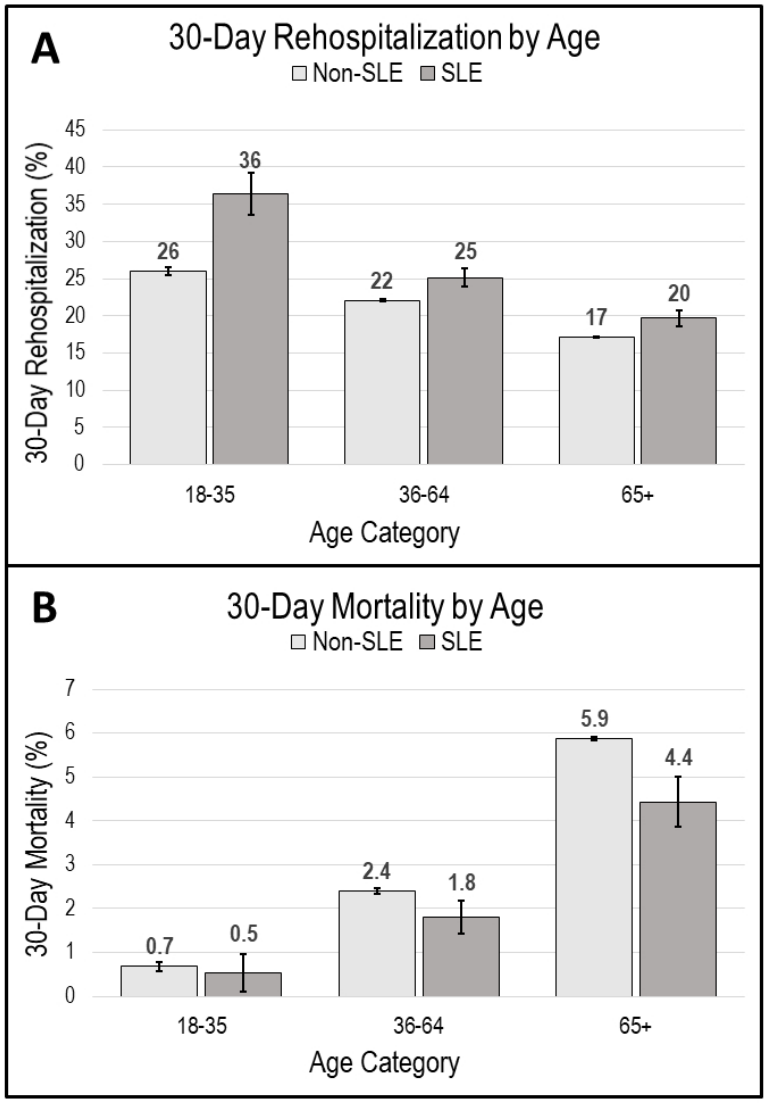

Figure 2. Observed 30-day rehospitalization rates (panel A) and mortality rates (panel B) among SLE (black) and non-SLE (grey) Medicare beneficiaries by age category. Error bars represent 95% confidence intervals.

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