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Lexi Ojener René Date

# 30-day Hospital Readmission of Georgia Lupus Registry Systemic Lupus Erythematosus Patients

By

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Master of Science in Public Health
Biostatistics & Bioinformatics

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By

Lexi Ojener René
B.S., Brooklyn College, City University of New York, 2013

Thesis Committee Chair: Reneé H. Moore, PhD
Thesis Committee Members: S. Sam Lim, MD, MPH
John Hanfelt, PhD

An abstract of
a thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Science in Public Health
in Biostatistics
2016

# Abstract

## 30-day Hospital Readmission of Georgia Lupus Registry Systemic Lupus Erythematosus Patients

By Lexi Ojener René

Systemic lupus erythematosus (SLE) is a chronic, autoimmune disease often afflicting younger minority women, in which a cure has yet to be found. This condition results in the body's immune system attacking healthy tissue, which potentially affects many parts of the body with mild or serious symptoms. Although there is no cure, SLE can be effectively treated with drugs. Due to the physical, as well as, psychological burdens that are associated with this disease, SLE inhibits people from completing their daily tasks; i.e., going to work/school. Because of this employment and insurance become difficult to maintain. Many SLE patients are insured by Medicare and Medicaid. Having SLE can lead to frequent utilization of health services with significant financial impact.

The Georgia Lupus Registry (GLR) conducted surveillance of SLE patients in Atlanta to develop a population- based registry geared towards better defining the incidence and prevalence of lupus. Supplementing the GLR data with Georgia Hospital Discharge Data provided insight into hospital utilization and readmission. Patients were categorized into three groups: never hospitalized, hospitalized with no readmission within 30 days and hospitalized with readmission within 30 days. Factors associated with 30-day hospital readmission among SLE patients were examined. Time to first hospital readmission within 30 days and associated baseline factors were analyzed.

Multivariable analyses showed that patients who live in census block groups with lower median income, and patients that meet the serositis (Odds Ratio [95% Confidence Interval]: 2.6 [1.4, 4.9]; p-value = 0.003) and renal disorder (OR [CI]: 1.95 [0.99, 3.83]; p-value = 0.05) American College of Rheumatology (ACR) criterion have higher odds of readmission within 30 days. Per $1,000 increase in median income, the odds of readmission is 0.98 [CI: 0.97, 0.99] times higher (p = 0.004). Multivariable survival analyses, omitting patients that were hospitalized with no readmission within 30 days, showed that patients who live in census block groups with lower income, and patients that meet the serositis ACR criterion (Hazard Ratio [CI]: 2.0 [1.3, 3.1]; p-value = 0.002) are at higher risk of readmission within 30 days. Per $1,000 increase in median income, the hazards ratio of readmission is 0.99 [CI: 0.98, 0.995] times higher (p = 0.003).

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**Acknowledgements**

I wish to thank various people for their contribution to this thesis:

I would like to express my deep gratitude for Dr. Sung Sam Lim for giving me the opportunity to work with his team at Grady Memorial Hospital for the duration of this program. I am very grateful to have received such patience, guidance, enthusiastic encouragement, support, advice and assistance, as well as, useful and thought-provoking critiques throughout all of this.

I would also like to thank Professor Reneé H. Moore for agreeing to chair my committee. Her willingness to assist, to give her time so generously, aid in answering any questions that I had, statistical or approaches to discussion, and her general support of me and my work has been greatly appreciated.

A special thanks to Professor John Hanfelt for agreeing to be my reader and being supportive of me throughout this process.

The completion of this project could not have been accomplished without the support and encouragement of my parents, as well as, my friends. Lastly, I would like to give a special thanks to my brother, who has always helped me through any programming issue that I've ever met, who has provided proof reading assistance, and who continuously supports, motivates and encourages me throughout my studies.

Thank you all so much!

# Table of Contents

## 1 Background

In autoimmune diseases, the immune system's response results in damage to an individual's healthy organs, tissues, or cells. More than 80 human diseases are found to have an autoimmune basis[1, 2]. Due to non-specific clinical manifestations and lack of definitive tests, they are often hard to diagnose. Autoimmune diseases are chronic, may be concurrent, and are life threatening. Lupus is one of many autoimmune diseases for which a cure has yet to be found.

According to the Lupus Foundation of America there are an estimated 1.5 million people who are living with lupus in the United States. There are several kinds of lupus: systemic lupus erythematosus (SLE), discoid lupus erythematosus, sub-acute cutaneous lupus erythematosus, drug-induced lupus, and neonatal lupus[1]. Most people develop lupus between the ages of 15 and 44, but anyone can develop lupus, including children. Lupus can affect many parts of the body, including the joints, skin, kidneys, heart, lungs, blood vessels, and the brain. In lupus patients, periods of illness are referred to as flares, and periods of no illness are referred to as remission. SLE is most often referred to as lupus since it is the most common subtype; from here on SLE and lupus will be used synonymously. This type of lupus mistakenly allows the body's immune system to attack healthy tissue, which affects many parts of the body with mild or serious symptoms. Although there is no cure, lupus can be effectively treated with drugs.

In the 1950s, an epidemiologic study revealed disproportionate incidence, prevalence and mortality rates among black females than whites[3]. More recent epidemiologic studies have found that African-American and Hispanic lupus patients tend to develop lupus earlier in life and experience more severe cases of the disease than Caucasian patients[4-6]. Some of the observed disparities may be associated with differences in access to health care, patient perceptions of disease, and assessments of disease activity by health care providers[6]. Lupus was also found to be more common in women of Hispanic, Asian, and Native American descent than in Caucasian women. Males reportedly have fewer SLE observed cases than women[3, 5, 7]. Pregnant women with lupus are considered high risk due to an increased risk of complications[8].

There is no single laboratory test that can determine if a person has lupus. To classify people as having SLE for studies, at least four of the American College of Rheumatology's (ACR) criteria must be met[9]. The criteria are: malar rash, discoid rash, photosensitivity, oral or nose ulcers, non-erosive arthritis, serositis, neurologic disorder, renal disorder, hematologic disorder, immunologic disorder, and positive antinuclear antibodies.

Due to difficulty of disease diagnosis as well as differences among case definitions, small population sizes, and dependency of self-report, the impact of SLE is more difficult to evaluate on a population level[2]. In 2002 the Center for Disease Control and Prevention (CDC) launched a project, as part of the "National Arthritis Action Plan: A Public Health Strategy" [2], to develop population- based registries geared towards better defining the incidence and prevalence of lupus. The CDC funded small grants to the health departments of 3 states. Areas with a population of more than 1 million having a large African-American proportion were considered eligible.

The Georgia Lupus Registry (GLR)[7] study was funded and conducted surveillance of SLE in two Georgia counties, Fulton and DeKalb; as they fit the eligibility for the minority population. To reduce bias in ascertainment and underreporting, Emory University partnered with the Georgia Department of Public Health to utilize the surveillance exemption to the HIPAA Privacy Rule to obtain protected health information without written patient consent. This information was crucial in determining whether diagnosed cases met the various case definition criteria and served to prevent duplicate patient records. Emory University was designated as the GLR's agent to provide lupus expertise and manage the project.

Lupus is associated with substantial direct cost burden in the United States[10]. Due to the physical as well as psychological burdens that are associated with this disease, SLE often inhibits people from completing many of their daily tasks; i.e., going to work/school[11]. As a result, employment and insurance become difficult to maintain. Many SLE patients are insured by Medicare and Medicaid[10]. In 2012, the Affordable Care Act created an additional section that established the Hospital Readmissions Reduction Program[12-14]. This program requires the Center for Medicare & Medicaid Services to reduce payments to inpatient prospective payment systems (IPPS) hospitals with excess readmissions. Therefore, it is

important to better understand the impact of having lupus and its associated factors on hospital readmission rates.

Due to all of the associated burdens and flares, SLE, as a chronic disease, can lead to frequent utilization of health services with significant financial impact[11]. In previous work, Dr. S. Sam Lim and Dr. Cristina Drenkard evaluated the influence of ethnicity and gender on the utilization and cost of emergency room visits and hospital admissions in early stages of SLE.[15] To do this they supplemented the Georgians Organized Against Lupus database with Georgia Hospital Discharge Data (HDD). Every hospital and emergency room in the state of Georgia is required to report all hospital admissions and emergency room visits to the Georgia Department of Public Health. The Georgia Hospital Discharge Data includes dates of admission and discharge, a patient's county of residency, direct costs based on standardized rates and up to 5 international classification of diseases (ICD) codes per admission.

To assess factors associated with hospital readmission and utilization of hospitals among SLE patients, the Georgia Hospital Discharge Data (HDD) supplemented the GLR database. There were four aims for this thesis. The first aim consisted of data analytics: the merging of several datasets and producing a numerical breakdown of the applied restrictions. The second objective was to report descriptive statistics of GLR SLE incident patients. These patients were categorized into three groups: never hospitalized, hospitalized with no readmission within 30 days and hospitalized with readmission within 30 days. The third aim was to report the prevalence of hospital readmission within 30 days. A secondary aim was to examine which baseline factors were associated with one or more 30-day hospital readmissions within the surveillance period. Baseline was defined at different times for a few variables. The baseline date for median income and proportion of high school graduates was defined as January 1, 1999. The baseline date for age and ACR criteria was defined by the date of diagnosis for each patient. The fourth aim was to determine the time to readmission within 30 days. A secondary aim was to compare the ICD 9 codes for readmission. Readmission groups were categorized by whether the principle ICD 9 code was the same between the last discharge and first readmission. Another secondary objective was to determine which baseline factors were associated with time to first readmission.

With this information, this project can potentially aid in better understanding risk factors for high admission and readmission rates in some patients with SLE and lead to modification of policies and preventive care, ultimately alleviating patients of worsening burden of disease and its comorbidities and hospitals of the financial burden.

## 2 Methods

### *2.1 Data Source and Population*

#### *2.1.0.1 Aim 1: Data analytics*

We used data from the Georgia Lupus Registry, Georgia Hospital Discharge Data and geocoded data from ZevRoss Spatial Analysis. The GLR collected information on SLE cases in Atlanta from January 1, 2002 through December 31, 2004. GLR SLE validation[7] was defined as followed:

1. ≥ 4 ACR criteria, or
2. Treating rheumatologist's diagnosis. Those with 3 ACR criteria were required to have a documented statement of diagnosis of SLE in the medical record by a board-certified rheumatologist, or
3. <4 ACR criteria plus lupus kidney disease as defined by either:
    a. a biopsy consistent with class II–VI lupus nephritis (7–9)
    b. end-stage renal disease (ESRD) requiring dialysis or renal transplantation with documentation of SLE in the medical record.

Incident patients were diagnosed with SLE within the GLR surveillance period. Due to the eligibility criteria of a large minority population, GLR data was restricted to Fulton and DeKalb counties. These patients' data were supplemented with 2002-2013 Georgia HDD. Because our primary focus was hospital admission, we excluded admissions to emergency rooms, emergency room/ambulatory surgery, and hospital-owned ambulatory surgery centers. Since our interest lied in how SLE affects hospital visitation, any hospital visits before SLE diagnosis was excluded from the hospital readmission analysis. In addition, if any patient had all of their hospital visits before their date of diagnosis, we considered them as SLE patients that were never admitted to the hospital due to SLE. To further restrict the data we limited

patient age to adults 18 years or older at the date of SLE diagnosis. The breakdown of individuals included in this analysis can be seen in Table 10.

### *2.2 Measures*

#### 2.2.1 Outcome Variables

From the first date of discharge, a 30-day interval was created. Any admission within that interval was considered a readmission. The interval reset once the period was completed. For intervals with readmission visits, the last date of discharge became the new start date of the 30-day interval. For intervals with no readmission, the next date of discharge became the new start date of the 30-day interval. An example of this can be seen in Table 12.

##### 2.2.1.1 Prevalence

To report prevalence of a 30-day hospital readmission, readmission was created as a binary variable. Either a patient was hospitalized with readmission within 30 days of their last discharge or they were not readmitted within 30 days.

##### 2.2.1.2 Time-to-event measures

Time to readmission was defined as the number of days between the date of admission and the most previous date of discharge. Patients who were hospitalized with no readmission within 30 days were omitted.

##### 2.2.1.3 Independent Variables

The GLR contained the following sociodemographic information: gender, date of birth, race, ethnicity, and marital status. It also contained major clinical features related to lupus. Baseline clinical factors included ACR criteria for SLE, and whether there were low complement levels (C3 and/or C4). All clinical features were coded as binary variables.

The geocoded data contained 1999 median family income and the proportion of the 25 year old and over population with a high school (HS) degree or greater, within each block group. The U.S. Census Bureau defines a block group as a statistical division of a small, relatively permanent statistical

subdivision of a county or equivalent entity[16]. Block groups generally contain between 600 and 3,000 people.

The HDD contained hospital admission dates, hospital discharge dates, ICD 9 codes, insurance providers as a primary payer and a standardized cost per hospitalization.

#### 2.2.1.4 Derived Variables

An estimate of disease severity was determined by the number of ACR criteria met at baseline. The higher the number, the worse the severity of the disease. Length of stay was created using the admission and discharge date to count the number of days each patient was hospitalized at their first hospital admission. Total number of hospitalizations summed the number of times a patient was hospitalized within the surveillance period. The insurance status was created using the insurance billed at the time of first hospital admission. Patients insured by Blue Cross/Blue Shield, commercial insurance, HMO/managed care, POS or PPO were considered insured. Patients covered by Georgia Better Health, Medicaid, Medicaid applicants or Medicaid managed care were considered insured by Medicaid. Patients covered by Medicare or Medicare managed care were considered insured by Medicare. Patients covered by Tricare or other providers were excluded from the variable insurance grouped, as it was too few patients to create its own category. Age was calculated at the date of diagnosis and at the time of first hospital admission.

### 2.2.2 Statistical Analysis

#### *2.2.2.1 Aim 2: Descriptive statistics of adult GLR SLE incident patients*

The baseline descriptive statistics were summarized in three different tables. The first table comprised of 2 groups of SLE patients that were: never hospitalized or hospitalized. The second table comprised of 3 groups of SLE patients that were: never hospitalized, hospitalized with no readmission within 30 days, or hospitalized with readmission within 30 days. The third table comprised of 2 groups of SLE patients that were: hospitalized with no readmission within 30 days or hospitalized with readmission within 30 days. All analyses were completed in SAS 9.4 (SAS Institute, Cary NC). Significance was defined at $\alpha$=0.05.

For each continuous variable from the GLR and the geocoded dataset, we reported the mean, standard deviation, median, first and third quartile, as well as, the minimum and maximum value. For comparison of two groups, a student t-test was conducted to test the difference of means between the groups. The T-statistic has n-1 degrees of freedom (df), where n is the total number of observations. To use the t-test we assume that the data follows the normal probability distribution, that the variances of the two groups are equal, that the characteristics are independent. The null hypothesis is that the means of characteristics are equal for the two groups. To use the t-test we confirmed all necessary assumptions. From the output, we report the mean difference between the two groups and the 95% confidence interval (CI). If the continuous data was not normally distributed, we used the non-parametric Wilcoxon-signed rank test was used; we only report the p-value. This test does not assume normality, it assumes that the sample we have is randomly taken from a population, with a symmetric frequency distribution, where we test the difference in the medians between groups.

For comparison of three groups, an analysis of variance (ANOVA) test was conducted. ANOVA is a statistical test for heterogeneity of means by analysis of group variances. The F-statistic has K(n-1) degrees of freedom, where K is the number of groups and n is the number of observations within each group. To use ANOVA we assume homoscedasticity, independence and normality of the residuals. The null hypothesis is that the means of all groups would be the same across the characteristic. We confirmed all necessary assumptions to use ANOVA.

For most comparisons of the nominal variables, a Chi-squared test was used to test for differences between groups. The $\chi^2$ statistic has *(r - 1) (c - 1)* df, where *r* represents the number of nominal levels in the table and *c* represents the number of groups. The $\chi^2$ test assumes that the characteristics are nominal or ordinal, there is independence between groups, and the expected cell values should be 5 or more in at least 80% of the cells, with no cell having an expected of less than one. The null hypothesis is that the number of characteristics in each category is equal to that of the alternative hypothesis, the observed numbers are different from the expected. When we had 20% or more cells with an expected

value less than or equal to 5, we used a Fisher's exact test. To use Fisher's we confirmed independence among observations and that the rows and columns are fixed. This test is based on the hypergeometric distribution. The null hypothesis is that the relative proportions are independent across groups.

In some cases where the cells contained expected values less than five, the Fisher's exact test calculations required too much time to compute. In these cases, we used both a Monte Carlo simulation and a Cochran-Mantel-Haenszel (CMH) test. The Monte Carlo method is a permutation that randomly chooses 10,000 tables and relies on the assumption that the parameter of interest has a normal sampling distribution; the p-value is based on the binomial distribution. The CMH general association test is similar to the $\chi^2$ test with *(r - 1) (c - 1)* df. This can be used when the row and column variables are both nominal. The alternative hypothesis of interest is that there is some association between the row and column variables.

#### *2.2.2.2 Aim 3: 30- day hospital readmission prevalence and associated factors*

Prevalence was reported as the sum of the number of patients that were ever hospitalized with readmission divided by the total number of patients with hospitalization data.

To examine which baseline factors were associated with our outcome of interest, hospital readmission (yes/no), we fit a univariate logistic regression for each characteristic. From the univariate logistic regression models, we considered any characteristic with Wald test p-value less than 0.20 as a candidate for the final multiple logistic regression model. This is a common strategy that allows a broader list of predictor variables for consideration in an effort to account for differences in univariate and multivariable associations with the outcome. All continuous variables were set to the base unit of 1 for a one- unit increase interpretation. The odds ratio estimates, Wald 95% CI, and associated p-value were reported from the logistic regression models. In the case of income, due to the high standard deviation and variance, we scaled this variable by 1000 for the univariate and multivariable analyses.

Once we identified characteristics from the univariate models significant at $\alpha = 0.20$, we included all of these variables in a multivariable logistic regression model. We then utilized the forward and backward automated selection procedures to select characteristics simultaneously significant at $\alpha = 0.05$

for the final multiple regression model. From the final model, we report the odds ratio, the Wald 95%CI, and the associated p-value.

#### *2.2.2.3 Aim 4: Time to first hospital readmission within 30 days*

To determine time to first hospital readmission, we conducted survival analysis (time-to- event). From previous coding of hospital readmission, we knew which patients were readmitted within 30-days of being hospitalized and which patients were never readmitted within 30-days of being hospitalized during the surveillance period. We restricted our data to look at patients that we knew to be readmitted during the surveillance period, since our interest lied in determining the time to readmission. To determine the time to readmission, we created a variable to determine the length of time between the date of readmission and the last date of discharge for every patient. Patients that were hospitalized but not readmitted within 30 days were omitted from this analysis. To determine time to event, we plotted a Kaplan- Meier curve. The Kaplan- Meier (KM) method involves the computation of probabilities of occurrence of event at a certain point of time and multiplies these successive probabilities by any earlier computed probabilities to get the final estimate. Ultimately, the graph shows the proportion of patients that are yet to be readmitted at a certain day, this drawn as a step function.

We also plotted a KM curve to see the difference in time-to-readmission, for patients who were readmitted, for the same or different ICD 9 code from their last discharge. We used the log-rank test to compare the time-to-readmission curves between these two groups. This test computes a $\chi^2$ test statistic with 1 df. The null hypothesis is that the time-to-readmission curves do not differ based on group. For KM and the log-rank test, we assume the time-to-readmission probabilities are the same for subjects across the entire surveillance period, the absence of competing risk, and the date of readmission is accurate.

To determine which baseline factors were associated with time to readmission, we only looked at patients that were readmitted within 30 days. For both the univariate and multivariable analysis, we conducted a Cox proportional hazards model. The Cox regression provides a hazard rate, which tells us the instantaneous risk of readmission at a point in time. It also computes a ratio of hazard rates for

comparison of groups. The Cox regression assumes proportional hazards and that the risk of readmission remains constant over time. For the univariate analysis, a cox regression was run on each variable of interest. We set the threshold on the $\chi^2$ test to a p-value cut-off point of 0.20. The hazards ratio, the hazards ratio 95% CI, and the associated $\chi^2$ p-value were reported.

For the multiple Cox regression model, we included all of the variables that met the threshold in the univariate analysis. We then ran automated models using forward and backward selection methods. Similar to the multiple logistic regression model, we utilized the forward and backward automated selection procedures to identify the characteristics simultaneously significant at $\alpha = 0.05$. This final multiple Cox regression model was reported with the hazard ratio, the hazard ratio 95%CI, and the associated p-value.

**3 Results**

There were a total of 343 GLR SLE incident patients that lived in Fulton and DeKalb counties. When supplemented with hospital discharge data, 307 SLE patients were found to have Hospital Discharge Data and 36 were not. Of the 307 patients, 253 were admitted to a hospital, the other 54 only had admission data into emergency rooms, ambulatory care, etc. We then eliminated all visits that were not considered a hospital admission and restricted the hospitalizations to the date after each patient's date of diagnosis. Since our interest was limited to hospital admissions of SLE adults, we imposed the age restriction to 18 years of age or older at the time of diagnosis. Our final dataset had 214 adult GLR SLE incident patients that were hospitalized during the surveillance period and 52 adult GLR SLE incident patients that were never hospitalized during the surveillance period (Table 10).

Overall, when comparing the patients that were never hospitalized (n = 52) to the patients that were hospitalized (n = 214), those hospitalized were generally older and lived in block groups where the median income was lower. Not all of the patients had geocoded information; each table with geocoded data specifies the sample size. Despite the difference in median income, the percent of high school graduates that lived in the block group were relatively similar. For both groups, more than 85% were

female and more than 60% were Black/African-American. Almost 90% of either population did not consider themselves Hispanic. In the never hospitalized group, 48% of the population was single and 34% was married; in comparison, in the hospitalized group, 45% of the population was married and 36% was single. A little less than half of the population for either group was found to have low C3 or low C4. For the clinical ACR criteria, the only statistically significant difference between the groups was found in patients that were found to have pleuritis or pericarditis (Table 1).

Based on our definition of hospital readmission, we found 118 (55%) patients were hospitalized with no readmission within 30 days throughout the entire surveillance period, and 96 (45%) patients were hospitalized with one or more readmission throughout the entire surveillance period. After comparing the three groups: never hospitalized, hospitalized with no readmission within 30 days, and hospitalized with readmission within 30 days, we found several statistically significant differences (Table 2). Stratifying the hospitalized group showed a significant income difference. Those who were hospitalized with readmission within 30 days lived in a block group with a much lower average median income. In addition, those who were hospitalized with readmission within 30 days had a higher average level of disease severity; the comparison of these three groups were found to be significant. In regards to the ACR criteria, comparing the three groups, the criteria of significance, in addition to the pleuritis and the pericarditis, were renal disorder and neurologic disorder. Patients that were readmitted within 30 days had higher proportions of criteria present as compared to the other two groups.

We fit additional models to further examine differences in patient characteristics for those readmitted within 30 days as compared to not readmitted with 30 days (last 2 groups in Table 2). Significant differences were found between these two groups in the following characteristics: income within block groups, percent of HS graduates within block groups, disease severity, pleuritis/pericarditis and renal disorder (Table 3).

The difference of the average median income within block groups was $16,492 (inter-quartile range= $17,147.50). In the hospitalized with no readmission group within 30 days, the income ranged from ~$15.7k to $200k; however, the lower income range in the hospitalized with readmission group

showed a $9k difference. The hospitalized with 30 day readmission lived in block groups where the median income ranged from ~$6.4k to $111k. Although the percent of HS graduates was not found to be significantly different, it is notable to mention that both the average and median percent of those who held a HS degree or above, were higher in the hospitalized with no readmission group. Patients who were readmitted within 30 days had an average of 5.1 (standard deviation= 1.5) total ACR criteria met, patients that were not readmitted within 30 days had an average of 4.4 (1.2) total ACR criteria met. 58 (60%) of the patients that were readmitted met the pleuritis/pericarditis criteria compared to, 39 (33%) of the patients that were not readmitted within 30 days. There were a total of 43 (45%) patients that were readmitted that met the renal disorder criteria, in comparison to the 27 (23%) that were not readmitted within 30 days.

We also examined group differences in first hospital admission characteristics (Table 4). Although we did not find a significant difference in total charges billed by the hospital, we did find a significant difference in length of stay. On average, patients that were readmitted stayed in the hospital 3.4 more days than patients that were never readmitted within 30 days. More than half of the patients in the never readmitted group were considered insured (66%), while less than half of the patients in the readmitted group were considered insured (42%). There were also more patients on Medicaid, Medicare, or Self-Pay in the readmitted group than there were in the never readmitted group. As an additional variable, we included the total number of hospitalizations for each patient over the entire surveillance period. Although there were less people in the readmitted group, there were, on average, 7 more hospital visits than in the group of patients that were never readmitted within 30 days; this was found to be statistically significant.

The univariate logistic regression variables of significance at $\alpha = 0.05$ were: median income of block group (scaled), disease severity, race, insurance at time of first visit, pleuritis/pericarditis, renal disorder, and hematologic disorder (Table 5). The additional variables that met the $\alpha = 0.20$ level for consideration in the multiple logistic regression model include: percent of HS graduates within block group, gender, photosensitivity, neurologic disorder, and positive antinuclear antibody (ANA). Due to the

retrospective collection of this data, all SLE patients at one point in time will test positive for ANA. Thus the ANA criterion was excluded from the multivariable analysis.

Both the forward and backward selection methods for the multiple logistic regression chose the same model. The variables that were simultaneously significant predictors of readmission within 30 days were: median income, pleuritis/pericarditis, and renal disorder (Table 6).

The respective regression coefficients are shown in Table 6. The overall model described by these variables was:

$$Probability\ of\ readmission\ = \frac{1}{1+e^{-z}}$$

where z = (-0.02*Income) + (0.48*Pleuritis/Pericarditis) + (0.33*Renal Disorder) + 0.97; and e is the mathematical constant and base value of natural logarithm. Per one thousand dollar increase in income, there is a 0.98 (95% CI: 0.97, 0.99) odds of readmission, while controlling for pleuritis/pericarditis and renal disorder. For a person with the same median income and meets the same ACR criteria for renal disorder, meeting the pleuritis/pericarditis ACR criteria increases the odds of readmission by a factor of 2.6 (95% CI: 1.4, 4.9). For a person with the same median income and meets the same ACR criteria for pleuritis/pericarditis, meeting the renal disorder ACR criteria increases the odds of readmission by a factor of 1.95 (95% CI: 0.99, 3.83).

Figure 1 shows the Kaplan Meier curve for time to readmission. Of the patients that were readmitted (n = 96), Table 9 shows that the median day of readmission was 8 days (95% CI: 5, 11) after discharge. Of the 96 people that were readmitted, 18 (19%) were readmitted to the hospital for the same ICD 9 code. Figure 2 shows the difference in time to readmission, of those readmitted, between the ICD 9 code groups. The most common principal ICD 9 codes at the first hospital visit for these two groups can be seen in Table 11. Patients that were readmitted for the same ICD 9 code were readmitted earlier than those who were readmitted for a different ICD 9 code (Table 9a). Of the patients that were readmitted for a different ICD 9 code, the median day of readmission was 8 days (95% CI: 5, 11) after discharge. Of the patients that were readmitted for the same ICD 9 code, half of the patients were readmitted to the hospital

at day 8.5 (95% CI: 2, 13). Despite the differences, there was no significant difference in the time to readmission between the two groups.

***Figure 1:*** Kaplan- Meier Time to First Readmission Curve

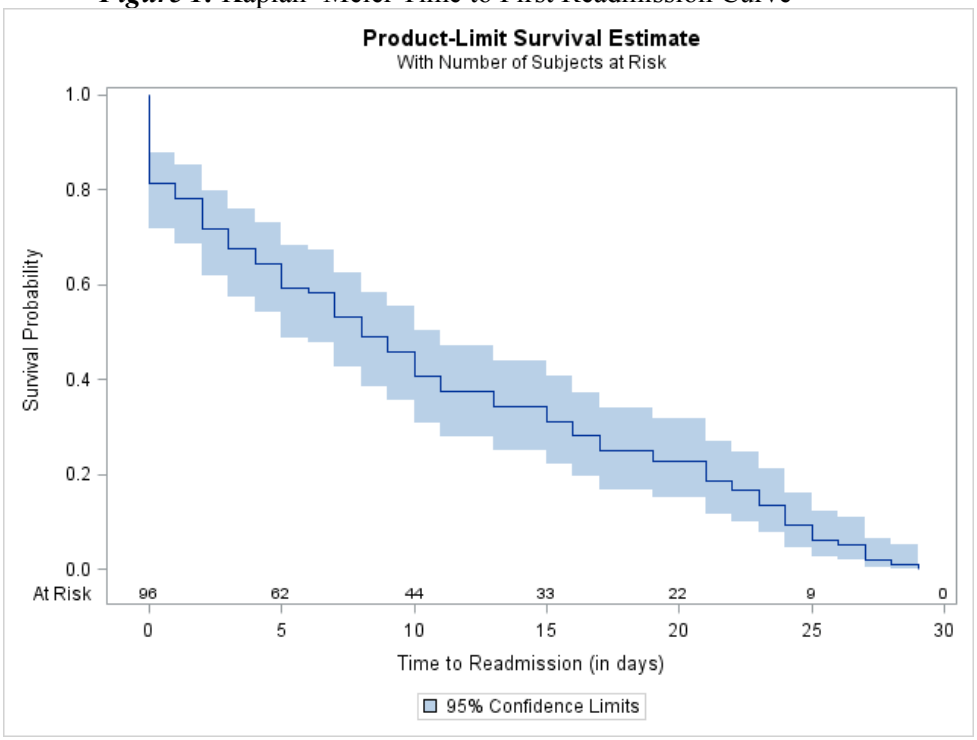
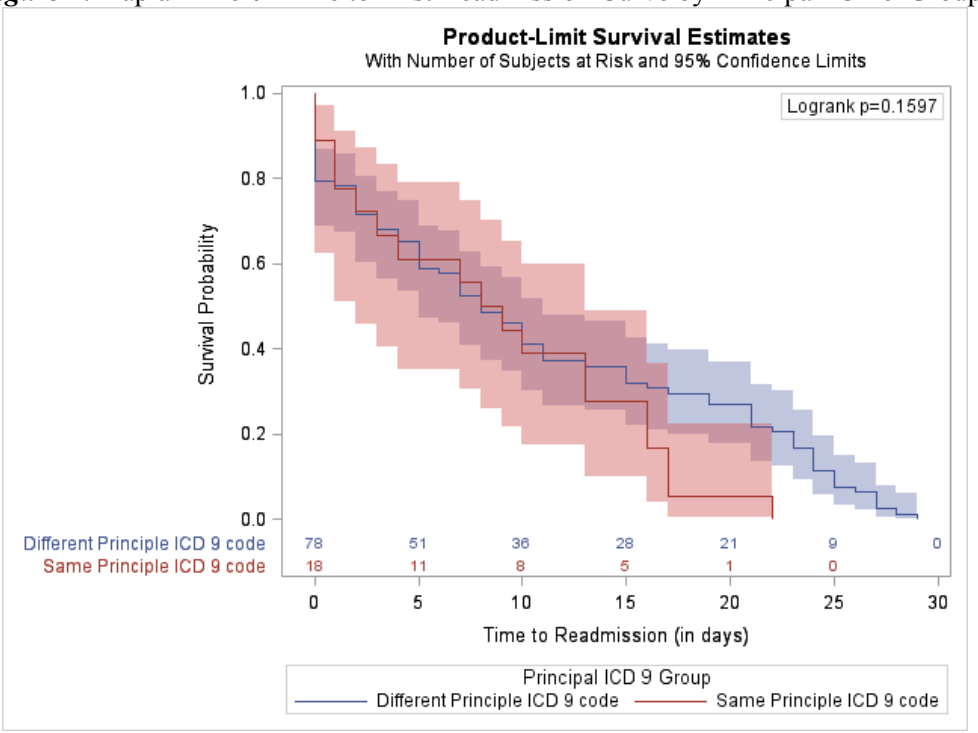



***Figure 2:*** Kaplan- Meier Time to First Readmission Curve by Principal ICD 9 Group



The univariate Cox regression variables of significance at an $\alpha = 0.05$ level were (Table 7): median income of block group (scaled), disease severity, race, insurance at time of first visit, pleuritis/pericarditis, and renal disorder. The additional variables that met the $\alpha = 0.20$ level for possible inclusion in the multiple Cox model: percent of HS graduates within block group, gender, photosensitivity, neurologic disorder, hematologic disorder, and positive antinuclear antibody (ANA). For the same clinical association of a positive ANA previously mentioned, this variable was excluded from the multivariable regression model.

Both the forward and backward selection methods for the multivariable cox regression chose the same model. The variables of significance were median income and pleuritis/pericarditis (Table 8). Based on hazard ratio, a patient with a $1,000 increase in median income is 0.99 times more likely to be readmitted to the hospital within 30 days. Given the same median income, a person with pleuritis/pericarditis is 2 times more likely to be readmitted to the hospital within 30 days.

## 4 Discussion

In this observational population based study of 343 GLR SLE incident patients, 214 (62%) were admitted to the hospital in Georgia between 2002 and 2013. For a cohort of newly diagnosed patients, it's remarkable that more than half were hospitalized within the first 11 years. Of the patients hospitalized within the surveillance period, about 45% of the patients were readmitted, at least once, to the hospital within 30 days. And of the patients that were readmitted, half of the patients were readmitted to the hospital a little over a week later. It's incredible to find that such a large number of patients were readmitted, especially having their first readmission within such a short period of time.

We hypothesized that health care utilization is associated to those with lower resources, education and higher disease activity. We found that readmissions occurred more frequently in patients that: live in a census block group with a lower average median income, live in a census block group with a lower average percent of high school graduates, meet more total ACR criteria, and specifically, meet the serositis, renal, neurologic, hematologic or immunologic ACR criteria. Readmission was significantly related to median income, disease severity, race, serositis, renal and hematologic ACR criteria. Most of

these findings are consistent with that of other studies, as well as our hypotheses. Due to the high-risk population, these findings may serve as a foundation to design better interventions or education to improve hospital readmission, which clearly disproportionately afflicts minorities.

In a previous study that examined hospital readmission of SLE patients at the hospital and state-level, it was found that age was inversely related to the risk of readmission [17]; however, in our study, we found no association between age and risk of readmission. Even though women are more likely to have SLE, we also found that gender had a non-significant relationship to readmission.

When analyzing the first hospital admission visit, we found that Medicaid or Medicare covered more patients that were readmitted than those who were never readmitted. And although the total cost of the first visit was higher in those readmitted, it was found to be non-significant between the two groups. Both the average and the median length of the stay in the hospital for the first hospital visit were found to be significantly higher in those who were considered readmitted. In addition, the average and the median total number of hospitalizations throughout the surveillance period were found to be significantly higher in those who were admitted. Using the comparison of the principal ICD 9 code assigned to the hospitalization to test for a difference in time-to- readmission was unique. With the Hospital Readmissions Reduction Program, Medicare and Medicaid reduce payments to inpatient prospective payment systems hospitals for excess readmissions. Repeating the analysis between ICD 9 codes and the time- to- readmission between the groups previously mentioned would be meaningful, as it further explores the insurance policies and it's accountability of hospitals.

Clinical considerations that were made include, the exclusion of the ANA criterion from the multivariable model. Patients with lupus are known to have had a positive ANA at one point in time; due to the retrospective methodology utilized in this study, it is probable that positive ANA test results were not found in the patient records, which is why not everyone was documented as having a positive ANA. Due to the retrospective collection of the data, we decided against the ANA criterion's inclusion.

Creating the final dataset was complex due to the data analytics and management. Combining several datasets of different formats, with different sizes and different patients took significant effort. The

HDD was in long format with repeated data, it also included patients that were not in the GLR. Much of the sociodemographic data in the HDD was similar to that of the GLR. For variables like marital status or ethnicity, there were differences in values as either relationship statuses changed or patients opted out of answering select questions; we utilized the GLR to identify these variables. In the geocoded data, the only identifier was one variable of identification. This variable needed to match throughout the other two datasets. However, there were two variables of identification in both the GLR and the HDD. Some of the patients had combinations of the identification variables. The HDD had location of discharge, but we did not take this into consideration since it's most likely not accurate and more than half of the patients had a routine discharge. Other variables of interest included whether patients were under certain treatments like dialysis; however, this data was mostly missing, therefore we were unable to include them in the analysis.

Completely matching all patients across the three datasets with the most accurate information was challenging. The GLR data itself was separated between two different datasets. To get exact numbers for the specified population, we had to stratify much of the data on several occasions. In the case of programming the code to count readmission, issues with sorting on admission and discharge dates played a major role in obtaining an accurate count. Using a variable that denoted each hospital visit per patient played an important role in merging the stratified hospital visits back into the complete dataset. Setting the two date restrictions for the population based on the date of diagnosis required the shifting of patients without actually removing patients. In general, keeping count of the numbers of patients in each group at each stage of restriction was particularly challenging.

The income variable was skewed, but its range was very wide compared to the rest of the data. Using the raw income in the logistic regression gave extremely small beta coefficients with even smaller standard errors. When SAS output the data, the variable gave a rounding error, estimating the odds ratio to 1 with a confidence interval of no range. We checked for normality using a q-q plot (Appendix Figure) and found that it was not normally distributed within the never hospitalized group and the hospitalized with no readmission within 30 days group; however, we failed to reject the Shapiro-Wilk normality test for the hospitalized with readmission within 30 days group. We also checked for confounding by

computing logistic regression models with other covariates but found none. Scaling income by 1000 before inputting it into a regression solved the issue and allowed us to see just how small the estimate and its confidence intervals truly were.

In conclusion, patients that live in block groups with lower income, patients that meet the pleuritis/pericarditis ACR criterion, and patients that meet the renal disorder ACR criterion should be paid extra attention upon being hospitalized. The odds of readmission within 30 days are higher for patients in those three categories. Patients that live in a block group with lower income and patients that meet the Pleuritis/pericarditis ACR criteria are also of higher risk for readmission within 30 days. For inpatient prospective payment systems hospitals that are subject to the Hospital Readmissions Reduction Program, the health systems and healthcare workers should identify lupus patients with these characteristics as they are at high risk for readmission. These findings can be used to drive programs to aid in improving outcomes and reducing health care utilization.

### *4.1 Limitations*

There are several limitations to this study. The geocoded data has information on the incident patients prior to the surveillance period. The GLR data was collected in a retrospective manner from medical records designed for clinical use and data varied across independent institutions or practices; leaving the concern for human error and underascertainment of all data. The degree of variability of clinical diagnosis by rheumatologists or the degree of experience of treating physicians cannot be determined. Race/ethnicity was assigned based on the physician assessment and may not reflect the patient's true self-identity. Due to underascertainment of the data, there were lower rates of documented ANA.

Although this research aids in examining SLE hospital readmission, we cannot make inferences about utilization without more information from the patient themselves. Our study was not provided with data on whether hospital visits were planned. We cannot assess the preventability of readmission since we were unable to evaluate the full medical record for confounding issues. We also did not have any identifying information on the hospitals or health care providers; clustering was not considered. Lastly,

we assume for disease severity that an increase in ACR criteria is evenly weighted between the criteria, however this is not clinically the case.

### *4.2 Future Work*

There are many different applications for this data set. With more research in this area, it is possible to identify other high-risk subsets that are at risk of readmission. There is a lack of literature regarding patients that are considered as "incomplete lupus" patients. These are patients that meet some of the criteria but not all. With this data, it is possible to evaluate health care utilization in the progression of the disease from incomplete to full lupus. In other chronic diseases, it was found that the quantity of medication given upon discharge is significantly related to 30-day hospital readmission[18]. It would be interesting to see if the trend plays a contributing role with SLE and the lower income population. In addition, a readmission rate using person-time-year could be useful to show what the SLE rate of readmission is in Georgia. Since the HDD has repeated measures, it is possible to create a subject specific model and account for all visits based on different measures of importance. It is also possible to create a general estimating equation model to make answer select questions about the lupus population.

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# 6 Appendix

## *6.1 Tables*

Table 1: GLR SLE patients categorized by Hospital Admission
Baseline Descriptive Statistics

| Characteristics | Never Hospitalized N = 52 | Hospitalized N = 214 | Mean Difference (95 % CI) | P-value |
|---|---|---|---|---|
| Age, (years) | | | | |
| Mean (SD*) | 39.4 (15.0) | 42.9 (15.6) | 3.5 (-1.2, 8.2) | 0.15 |
| Median (Q1, Q3) | 37.5 (27.5, 47.5) | 40.5 (31.0, 53.0) | | |
| Min, Max | (18.0, 84.0) | (18.0, 86.0) | | |
| Median Income within Census Block ($) | N = 42 | N = 184 | | |
| Mean (SD*) | 65,241.8 (39,776.1) | 55,677.7 (31,487.6) | | 0.18Ψ |
| Median (Q1, Q3) | 50,534.0 (40,074.0, 72,222.0) | 47,955.0 (34,389.0, 70,546.0) | | |
| Min, Max | (19,500.0, 192,761.0) | (6,402.0, 200,001.0) | | |
| HS Graduates within Census Block (%) | N = 42 | N = 184 | | |
| Mean (SD*) | 85.4 (11.8) | 82.5 (13.3) | -2.9 (-7.3, 1.5) | 0.19 |
| Median (Q1, Q3) | 89.2 (76.2, 95.6) | 86.4 (74.3, 93.1) | | |
| Min, Max | (50.2, 98.6) | (39.4, 100.0) | | |
| Disease Severity | | | | |
| Mean (SD*) | 4.4 (1.1) | 4.7 (1.4) | 0.3 (-0.02, 0.7) | 0.07 |
| Median (Q1, Q3) | 4.0 (4.0, 5.0) | 4.0 (4.0, 6.0) | | |
| Min, Max | (1.0, 7.0) | (3.0, 11.0) | | |
| | | | | |
| Gender | | | | |
| Male | 8.0 (15.4) | 27.0 (12.6) | | 0.60 |
| Female | 44.0 (84.6) | 187.0 (87.4) | | |
| Race | | | | |
| Asian | - | 1.0 (0.5) | | 0.001° |
| Black or African-American | 33.0 (63.5) | 167.0 (78.0) | | |
| Multiracial | 4.0 (7.7) | 4.0 (1.9) | | |
| White | 15.0 (28.9) | 42.0 (19.6) | | |
| Ethnicity | | | | |
| Hispanic | 3.0 (5.8) | 6.0 (2.8) | | 0.03° |
| Not Hispanic | 46.0 (88.5) | 201.0 (93.9) | | |
| Unknown | 3.0 (5.8) | 7.0 (3.3) | | |
| Marital Status | | | | |
| Divorced | 5.0 (10.0) | 22.0 (10.3) | | 0.03° |
| Married | 17.0 (34.0) | 96.0 (44.9) | | |
| Separated | 1.0 (2.0) | 3.0 (1.4) | | |
| Single | 24.0 (48.0) | 76.0 (35.5) | | |
| Unknown | 3.0 (6.0) | 2.0 (0.9) | | |
| Widowed | - | 15.0 (7.0) | | |
| Low C3 | | | | |
| Absent | 86 (55.5) | 21 (53.9) | | 0.85 |
| Present | 69 (44.5) | 18 (46.1) | | |
| Low C4 | | | | |
| Absent | 82 (52.6) | 23 (59.0) | | 0.47 |
| Present | 74 (47.4) | 16 (41.0) | | |
| ACR Criteria | | | | |
| Malar Rash | | | | |
| No Malar Rash | 42.0 (80.8) | 178.0 (83.2) | | 0.68 |
| Malar Rash | 10.0 (19.2) | 36.0 (16.8) | | |

Table 1: GLR SLE patients categorized by Hospital Admission
Baseline Descriptive Statistics

| Characteristics | Never Hospitalized N = 52 | Hospitalized N = 214 | Mean Difference (95 % CI) | P-value |
|---|---|---|---|---|
| Discoid Rash | | | | |
| No Discoid Rash | 44.0 (84.6) | 181.0 (84.6) | | 0.99 |
| Discoid Rash | 8.0 (15.4) | 33.0 (15.4) | | |
| Photosensitivity | | | | |
| No Photosensitivity | 43.0 (82.7) | 184.0 (86.0) | | 0.55 |
| Photosensitivity | 9.0 (17.3) | 30.0 (14.0) | | |
| Oral Ulcer | | | | |
| No Oral Ulcers | 42.0 (80.8) | 167.0 (78.0) | | 0.67 |
| Oral Ulcers | 10.0 (19.2) | 47.0 (22.0) | | |
| Non-erosive Arthritis | | | | |
| No Non-erosive Arthritis | 18.0 (34.6) | 78.0 (36.5) | | 0.81 |
| Non-erosive Arthritis | 34.0 (65.4) | 136.0 (63.6) | | |
| Pleuritis or Pericaditis | | | | |
| No Pleuritis or Pericarditis | 39.0 (75.0) | 117.0 (54.7) | | 0.008 |
| Pleuritis or Pericarditis | 13.0 (25.0) | 97.0 (45.3) | | |
| Renal Disorder | | | | |
| No Renal Disorder | 37.0 (71.2) | 144.0 (67.3) | | 0.59 |
| Renal Disorder | 15.0 (28.9) | 70.0 (32.7) | | |
| Neurologic Disorder | | | | |
| No Neurologic Disorder | 51.0 (98.1) | 193.0 (90.2) | | 0.09 |
| Neurologic Disorder | 1.0 (1.9) | 21.0 (9.8) | | |
| Hematologic Disorder | | | | |
| No Hematologic Disorder | 7.0 (13.5) | 31.0 (14.5) | | 0.85 |
| Hematologic Disorder | 45.0 (86.5) | 183.0 (85.5) | | |
| Immunologic Disorder | | | | |
| No Immunologic Disorder | 17.0 (32.7) | 64.0 (29.9) | | 0.70 |
| Immunologic Disorder | 35.0 (67.3) | 150.0 (70.1) | | |
| Positive ANA | | | | |
| No Positive Antinuclear Antibody | 4.0 (7.7) | 10.0 (4.7) | | 0.49° |
| Positive Antinuclear Antibody | 48.0 (92.3) | 204.0 (95.3) | | |

All values expressed as N (%) unless otherwise noted.

* SD= Standard Deviation
° Fisher's Exact Test
Ψ Wilcoxon signed-rank test

Table 2. GLR SLE categorized by Hospital Admission and Readmission
Baseline Summary Statistics

| Characteristics | Never Hospitalized N = 52 | Hospitalized with no readmission within 30 days N = 118 | Hospitalized with readmission within 30 days N = 96 | P-value |
|---|---|---|---|---|
| Age, (years) | | | | |
| Mean (SD*) | 39.4 (15.0) | 42.9 (15.0) | 43.0 (16.3) | |
| Median (Q1, Q3) | 37.5 (27.5, 47.5) | 42.0 (31.0, 52.0) | 39.0 (30.5, 55.5) | 0.35 |
| Min, Max | (18.0, 84.0) | (18.0, 86.0) | (18.0, 81.0) | |
| Median Income within Census Block ($) | N = 42 | N = 99 | N = 85 | |
| Mean (SD*) | 65,241.8 (39,776.1) | 63,296.3 (36,503.8) | 46,804.2 (21,384.3) | |
| Median (Q1, Q3) | 50,534.0 (40,074.0, 72,222.0) | 55,707.0 (37,261.0, 75,163.0) | 45,714.0 (32,778.0, 61,131.0) | 0.008Ψ |
| Min, Max | (19,500.0, 192,761.0) | (15,761.0, 200,001.0) | (6,402.0, 111,073.0) | |
| HS Graduates within Census Block (%) | N = 42 | N = 99 | N = 85 | |
| Mean (SD*) | 85.4 (11.8) | 84.0 (12.7) | 80.7 (13.9) | |
| Median (Q1, Q3) | 89.2 (76.2, 95.6) | 87.5 (74.8, 94.6) | 84.9 (73.7, 91.5) | 0.10 |
| Min, Max | (50.2, 98.6) | (42.5, 100.0) | (39.4, 97.9) | |
| Disease Severity | | | | |
| Mean (SD*) | 4.4 (1.1) | 4.4 (1.2) | 5.1 (1.5) | |
| Median (Q1, Q3) | 4.0 (4.0, 5.0) | 4.0 (4.0, 5.0) | 5.0 (4.0, 6.0) | <0.0001 |
| Min, Max | (3.0, 7.0) | (3.0, 8.0) | (3.0, 11.0) | |
| Gender | | | | |
| Male | 8.0 (15.4) | 11.0 (9.3) | 16.0 (16.7) | 0.25 |
| Female | 44.0 (84.6) | 107.0 (90.7) | 80.0 (83.3) | |
| Race | | | | |
| Asian | - | 1.0 (0.9) | - | |
| Black or African-American | 33.0 (63.5) | 85.0 (72.0) | 82.0 (85.4) | 0.007° |
| Multiracial | 4.0 (7.7) | 3.0 (2.5) | 1.0 (1.0) | |
| White | 15.0 (28.9) | 29.0 (24.6) | 13.0 (13.5) | |
| Ethnicity | | | | |
| Hispanic | 3.0 (5.8) | 4.0 (3.4) | 2.0 (2.1) | |
| Not Hispanic | 46.0 (88.5) | 109.0 (92.4) | 92.0 (95.8) | 0.53° |
| Unknown | 3.0 (5.8) | 5.0 (4.2) | 2.0 (2.1) | |
| Marital Status | | | | |
| Divorced | 5.0 (10.0) | 12.0 (10.2) | 10.0 (10.4) | |
| Married | 17.0 (34.0) | 55.0 (46.6) | 41.0 (42.7) | |
| Separated | 1.0 (2.0) | 2.0 (1.7) | 1.0 (1.0) | 0.10∴ |
| Single | 24.0 (48.0) | 43.0 (36.4) | 33.0 (34.4) | 0.13∇ |
| Unknown | 3.0 (6.0) | - | 2.0 (2.1) | |
| Widowed | - | 6.0 (5.1) | 9.0 (9.4) | |
| Low C3 | | | | |
| Absent | 21 (53.9) | 46 (58.2) | 40 (52.6) | 0.77 |
| Present | 18 (46.1) | 33 (41.8) | 36 (47.4) | |
| Low C4 | | | | |
| Absent | 23 (59.0) | 41 (51.9) | 41 (53.3) | 0.76 |
| Present | 16 (41.0) | 38 (48.1) | 36 (46.7) | |
| ACR Criteria | | | | |
| Malar Rash | | | | |
| No Malar Rash | 42.0 (80.8) | 101.0 (85.6) | 77.0 (80.2) | 0.54 |
| Malar Rash | 10.0 (19.2) | 17.0 (14.4) | 19.0 (19.8) | |
| Discoid Rash | | | | |
| No Discoid Rash | 44.0 (84.6) | 99.0 (83.9) | 82.0 (85.4) | 0.95 |
| Discoid Rash | 8.0 (15.4) | 19.0 (16.1) | 14.0 (14.6) | |
| Photosensitivity | | | | |
| No Photosensitivity | 43.0 (82.7) | 98.0 (83.1) | 86.0 (89.6) | 0.34 |
| Photosensitivity | 9.0 (17.3) | 20.0 (17.0) | 10.0 (10.4) | |
| Oral Ulcer | | | | |
| No Oral Ulcers | 42.0 (80.8) | 93.0 (78.8) | 74.0 (77.1) | 0.87 |

Table 2. GLR SLE categorized by Hospital Admission and Readmission
Baseline Summary Statistics

| Characteristics | Never Hospitalized N = 52 | Hospitalized with no readmission within 30 days N = 118 | Hospitalized with readmission within 30 days N = 96 | P-value |
|---|---|---|---|---|
| Oral Ulcers | 10.0 (19.2) | 25.0 (21.2) | 22.0 (22.9) | |
| Non-erosive Arthritis | | | | |
| No Non-erosive Arthritis | 18.0 (34.6) | 43.0 (36.4) | 35.0 (36.5) | 0.97 |
| Non-erosive Arthritis | 34.0 (65.4) | 75.0 (63.6) | 61.0 (63.5) | |
| Pleuritis or Pericaditis | | | | |
| No Pleuritis or Pericarditis | 39.0 (75.0) | 79.0 (67.0) | 38.0 (39.6) | <0.0001 |
| Pleuritis or Pericarditis | 13.0 (25.0) | 39.0 (33.1) | 58.0 (60.4) | |
| Renal Disorder | | | | |
| No Renal Disorder | 37.0 (71.2) | 91.0 (77.1) | 53.0 (55.2) | 0.003 |
| Renal Disorder | 15.0 (28.9) | 27.0 (22.9) | 43.0 (44.8) | |
| Neurologic Disorder | | | | |
| No Neurologic Disorder | 51.0 (98.1) | 110.0 (93.2) | 83.0 (86.5) | 0.04 |
| Neurologic Disorder | 1.0 (1.9) | 8.0 (6.8) | 13.0 (13.5) | |
| Hematologic Disorder | | | | |
| No Hematologic Disorder | 7.0 (13.5) | 22.0 (18.6) | 9.0 (9.4) | 0.15 |
| Hematologic Disorder | 45.0 (86.5) | 96.0 (81.4) | 87.0 (90.6) | |
| Immunologic Disorder | | | | |
| No Immunologic Disorder | 17.0 (32.7) | 39.0 (33.1) | 25.0 (26.0) | 0.50 |
| Immunologic Disorder | 35.0 (67.3) | 79.0 (67.0) | 71.0 (74.0) | |
| Positive ANA | | | | |
| No Positive Antinuclear Antibody | 4.0 (7.7) | 8.0 (6.8) | 2.0 (2.1) | 0.21 |
| Positive Antinuclear Antibody | 48.0 (92.3) | 110.0 (93.2) | 94.0 (97.9) | |

All values expressed as N (%) unless otherwise noted.

* SD= Standard Deviation
° Fisher's Exact Test
Ψ Wilcoxon signed-rank test
∴ Fisher's Exact Test- Monte Carlo Simulation
∇Cochran-Mantel-Haenszel General Association

Table 3: Hospitalized with no readmission within 30days vs. Hospitalized with readmission within 30days
Baseline Characteristics

| Characteristics | Hospitalized with no readmission within 30 days N = 118 | Hospitalized with readmission within 30 days N = 96 | Mean Difference (95 % CI) | P-value |
|---|---|---|---|---|
| Age, (years) | | | | |
| Mean (SD*) | 42.9 (15.0) | 43.0 (16.3) | | |
| Median (Q1, Q3) | 42.0 (31.0, 52.0) | 39.0 (30.5, 55.5) | -0.2 (-4.4, 4.1) | 0.94 |
| Min, Max | (18.0, 86.0) | (18.0, 81.0) | | |
| Median Income within Census Block ($) | N = 99 | N = 85 | | |
| Mean (SD*) | 63,296.3 (36,503.8) | 46,804.2 (21,384.3) | | |
| Median (Q1, Q3) | 55,707.0 (37,261.0, 75,163.0) | 45,714.0 (32,778.0, 61,131.0) | | 0.005$^{\Psi}$ |
| Min, Max | (15,761.0, 200,001.0) | (6,402.0, 111,073.0) | | |
| HS Graduates within Census Block (%) | N = 99 | N = 85 | | |
| Mean (SD*) | 84.0 (12.7) | 80.7 (13.9) | | |
| Median (Q1, Q3) | 87.5 (74.8, 94.6) | 84.9 (73.7, 91.5) | 3.3 (-0.6, 7.2) | 0.09 |
| Min, Max | (42.5, 100.0) | (39.4, 97.9) | | |
| Disease Severity | | | | |
| Mean (SD*) | 4.4 (1.2) | 5.1 (1.5) | | |
| Median (Q1, Q3) | 4.0 (4.0, 5.0) | 5.0 (4.0, 6.0) | -0.8 (-1.1, -0.4) | <0.0001 |
| Min, Max | (3.0, 8.0) | (3.0, 11.0) | | |
| | | | | |
| Gender | | | | |
| Male | 11.0 (9.3) | 16.0 (16.7) | | 0.11 |
| Female | 107.0 (90.7) | 80.0 (83.3) | | |
| Race | | | | |
| Asian | 1.0 (0.9) | - | | |
| Black or African-American | 85.0 (72.0) | 82.0 (85.4) | | 0.08 |
| Multiracial | 3.0 (2.5) | 1.0 (1.0) | | |
| White | 29.0 (24.6) | 13.0 (13.5) | | |
| Ethnicity | | | | |
| Hispanic | 4.0 (3.4) | 2.0 (2.1) | | |
| Not Hispanic | 109.0 (92.4) | 92.0 (95.8) | | 0.62 |
| Unknown | 5.0 (4.2) | 2.0 (2.1) | | |
| Marital Status | | | | |
| Divorced | 12.0 (10.2) | 10.0 (10.4) | | |
| Married | 55.0 (46.6) | 41.0 (42.7) | | |
| Separated | 2.0 (1.7) | 1.0 (1.0) | | 0.08 |
| Single | 43.0 (36.4) | 33.0 (34.4) | | |
| Unknown | - | 2.0 (2.1) | | |
| Widowed | 6.0 (5.1) | 9.0 (9.4) | | |
| Low C3 | N = 79 | N = 76 | | |
| Absent | 46.0 (58.2) | 40.0 (52.6) | | 0.87 |
| Present | 33.0 (41.8) | 36.0 (47.4) | | |
| Low C4 | N = 79 | N = 77 | | |
| Absent | 41.0 (51.9) | 41.0 (53.3) | | 0.29 |
| Present | 38.0 (48.1) | 36.0 (46.8) | | |
| ACR Criteria | | | | |
| Malar Rash | | | | |
| No Malar Rash | 101.0 (85.6) | 77.0 (80.2) | | 0.29 |
| Malar Rash | 17.0 (14.4) | 19.0 (19.8) | | |
| Discoid Rash | | | | |
| No Discoid Rash | 99.0 (83.9) | 82.0 (85.4) | | 0.76 |
| Discoid Rash | 19.0 (16.1) | 14.0 (14.6) | | |
| Photosensitivity | | | | |
| No Photosensitivity | 98.0 (83.1) | 86.0 (89.6) | | 0.17 |
| Photosensitivity | 20.0 (17.0) | 10.0 (10.4) | | |
| Oral Ulcer | | | | |

Table 3: Hospitalized with no readmission within 30days vs. Hospitalized with readmission within 30days
Baseline Characteristics

| Characteristics | Hospitalized with no readmission within 30 days N = 118 | Hospitalized with readmission within 30 days N = 96 | Mean Difference (95 % CI) | P-value |
|---|---|---|---|---|
| No Oral Ulcers | 93.0 (78.8) | 74.0 (77.1) | | 0.76 |
| Oral Ulcers | 25.0 (21.2) | 22.0 (22.9) | | |
| Non-erosive Arthritis | | | | |
| No Non-erosive Arthritis | 43.0 (36.4) | 35.0 (36.5) | | 1.0 |
| Non-erosive Arthritis | 75.0 (63.6) | 61.0 (63.5) | | |
| Pleuritis or Pericaditis | | | | |
| No Pleuritis or Pericarditis | 79.0 (67.0) | 38.0 (39.6) | | <0.0001 |
| Pleuritis or Pericarditis | 39.0 (33.1) | 58.0 (60.4) | | |
| Renal Disorder | | | | |
| No Renal Disorder | 91.0 (77.1) | 53.0 (55.2) | | 0.0007 |
| Renal Disorder | 27.0 (22.9) | 43.0 (44.8) | | |
| Neurologic Disorder | | | | |
| No Neurologic Disorder | 110.0 (93.2) | 83.0 (86.5) | | 0.10 |
| Neurologic Disorder | 8.0 (6.8) | 13.0 (13.5) | | |
| Hematologic Disorder | | | | |
| No Hematologic Disorder | 22.0 (18.6) | 9.0 (9.4) | | 0.06 |
| Hematologic Disorder | 96.0 (81.4) | 87.0 (90.6) | | |
| Immunologic Disorder | | | | |
| No Immunologic Disorder | 39.0 (33.1) | 25.0 (26.0) | | 0.27 |
| Immunologic Disorder | 79.0 (67.0) | 71.0 (74.0) | | |
| Positive ANA | | | | |
| No Positive Antinuclear Antibody | 8.0 (6.8) | 2.0 (2.1) | | 0.19° |
| Positive Antinuclear Antibody | 110.0 (93.2) | 94.0 (97.9) | | |

All values expressed as N (%) unless otherwise noted.

* SD= Standard Deviation
° Fisher's Exact Test
Ψ Wilcoxon signed-rank test

Table 4: Hospitalized with no readmission within 30 days vs. Hospitalized with readmission within 30 days
First hospital visit statistics

| Characteristics | Hospitalized with no readmission within 30 days N = 118 | Hospitalized with readmission within 30 days N = 96 | Mean Difference (95% CI) | P-value |
|---|---|---|---|---|
| Age, (years) | | | | |
| Mean (SD*) | 45.2 (15.2) | 44.1 (16.7) | 1.1 (-3.2, 5.4) | 0.61 |
| Median (Q1, Q3) | 43.0 (34.0, 55.0) | 40.0 (30.5, 57.0) | | |
| Min, Max | (18.0, 92.0) | (19.0, 84.0) | | |
| Length of Stay (days) | | | | |
| Mean (SD*) | 5.9 (6.1) | 9.3 (10.0) | -3.4 -(-5.7 -, 1.1) | 0.004 |
| Median (Q1, Q3) | 4.0 (2.0, 7.0) | 5.0 (3.0, 13.5) | | |
| Min, Max | (1.0, 30.0) | (1.0, 59.0) | | |
| Total Charges ($) | | | | |
| Mean (SD*) | 28,933.8 (52,334.9) | 31,897.0 (39,822.6) | -2,963.2 (-15,388.5, 9,462.1) | 0.64 |
| Median (Q1, Q3) | 15,793.5 (9,899.0, 26,281.0) | 16,081.0 (9,182.5, 43,033.5) | | |
| Min, Max | (2,573.0, 449,123.0) | (1,106.0, 274,764.0) | | |
| Total Number of Hospitalizations (N) | | | | |
| Mean (SD*) | 2.4 (1.8) | 9.2 (7.5) | -6.9 (-8.4 -, 5.3) | <0.0001 |
| Median (Q1, Q3) | 2.0 (1.0, 3.0) | 6.0 (5.0, 10.5) | | |
| Min, Max | (1.0 9.0) | (2.0 38.0) | | |
| Insurance | | | | |
| Blue Cross / Blue Shield | 7 (6.0) | 8 (8.5) | - | 0.005∴ 0.01∇ |
| Commercial Insurance | 12 (10.3) | 4 (4.3) | | |
| Georgia Better Health | - | 4 (4.3) | | |
| HMO/Managed Care | 45 (38.5) | 26 (27.7) | | |
| Medicaid | 5 (4.3) | 11 (11.7) | | |
| Medicaid Applicants | 9 (7.7) | 8 (8.5) | | |
| Medicaid Managed Care | 1 (0.9) | - | | |
| Medicare | 14 (12.0) | 17 (18.1) | | |
| Medicare Managed Care | 2 (1.7) | 2 (2.1) | | |
| Other | - | 1 (1.1) | | |
| POS | 9 (2.6) | 1 (1.1) | | |
| PPO | 9 (7.7) | - | | |
| Self-Pay | 9 (7.7) | 12 (12.8) | | |
| Tricare | 1 (0.9) | - | | |
| Insurance Grouped | | | | |
| Insured | 76 (66.5) | 39 (41.9) | - | 0.008 |
| Medicaid | 15 (12.9) | 23 (24.7) | | |
| Medicare | 16 (13.8) | 19 (20.4) | | |
| Self-Pay | 9 (7.8) | 12 (12.9) | | |

All values expressed as N (%) unless otherwise noted.

* SD= Standard Deviation
∴ Fisher's Exact Test- Monte Carlo Simulation
∇ Cochran – Mantel – Haenszel

Table 5: Univariate Odds of Hospital Readmission within 30 days

| Characteristic | Odds Ratio (95% CI) | P- Value |
|---|---|---|
| Age at Baseline | | |
| Per year increase | 1.00 (0.98, 1.02) | 0.94 |
| Median Income within Census Block | | |
| Per one thousand dollar increase | 0.98 (0.97, 0.99) | 0.0007 |
| HS Graduates within Census Block | | |
| Per one percent increase | 0.98 (0.96, 1.00) | 0.10 |
| Disease Severity | | |
| Per one ACR criteria increase | 1.52 (1.23, 1.89) | 0.0001 |
| Gender | | |
| Female vs. Male | 0.5 (0.2, 1.2) | 0.11 |
| Race | | |
| Black vs. Non-Black | 2.3 (1.1, 4.6) | 0.02 |
| Ethnicity | | 0.58 |
| Hispanic vs. Non- Hispanic | 0.6 (0.1, 3.3) | 0.88 |
| Unknown vs. Non- Hispanic | 0.5 (0.1, 2.5) | 0.61 |
| Marital Status | | 0.79 |
| Divorced vs. Single | 1.1 (0.4, 2.8) | 0.95 |
| Married vs. Single | 0.97 (0.5, 1.8) | 0.79 |
| Separated vs. Single | 0.7 (0.1, 7.5) | 0.62 |
| Widowed vs. Single | 1.95 (0.6, 6.0) | 0.22 |
| Insurance (at time of first visit) | | 0.009 |
| Medicaid vs. Insured | 3.0 (1.4, 6.4) | 0.20 |
| Medicare vs. Insured | 2.3 (1.1, 5.0) | 0.69 |
| Self- pay vs. Insured | 2.6 (1.0, 6.7) | 0.51 |
| Low C3 | | |
| Present vs. Absent | 1.3 (0.7, 2.4) | 0.48 |
| Low C4 | | |
| Present vs. Absent | 0.9 (0.5, 1.8) | 0.87 |
| ACR Criteria | | |
| Malar Rash | | |
| Malar Rash vs. No Malar Rash | 1.5 (0.7, 3.0) | 0.30 |
| Discoid Rash | | |
| Discoid Rash vs. No Discoid Rash | 0.9 (0.4, 1.9) | 0.76 |
| Photosensitivity | | |
| Photosensitivity vs. No Photosensitivity | 0.6 (0.3, 1.3) | 0.17 |
| Oral Ulcer | | |

Table 5: Univariate Odds of Hospital Readmission within 30 days

| Characteristic | Odds Ratio (95% CI) | P- Value |
|---|---|---|
| Oral Ulcers vs. No Oral Ulcers | 1.1 (0.6, 2.1) | 0.76 |
| Non-erosive Arthritis | | |
| Non-erosive Arthritis vs. No Non-erosive Arthritis | 1.0 (0.6, 1.7) | 1.00 |
| Pleuritis or Pericarditis | | |
| Pleuritis or Pericarditis vs. No Pleuritis or Pericarditis | 3.09 (1.8, 5.4) | <0.0001 |
| Renal Disorder | | |
| Renal Disorder vs. No Renal Disorder | 2.7 (1.5, 4.9) | 0.0008 |
| Neurologic Disorder | | |
| Neurologic Disorder vs. No Neurologic Disorder | 2.2 (0.9, 5.4) | 0.10 |
| Hematologic Disorder | | |
| Hematologic Disorder vs. No Hematologic Disorder | 2.2 (1.0, 5.1) | 0.06 |
| Immunologic Disorder | | |
| Immunologic Disorder vs. No Immunologic Disorder | 1.4 (0.8, 2.5) | 0.27 |
| Positive Antinuclear Antibody | | |
| Positive Antinuclear Antibody vs. No Positive Antinuclear Antibody | 3.4 (0.7, 16.5) | 0.13 |

Table 6: Multivariable Odds and Beta Coefficients of Hospital Readmission within 30 days

| Characteristic/Parameter | Beta Estimate | Standard Error | Odds Ratio (95% CI) | P-value |
|---|---|---|---|---|
| Intercept | 0.97 | 0.36 | | 0.008 |
| Median Income within Census Block | -0.02 | 0.006 | | 0.004 |
| Per one thousand dollar increase | | | 0.98 (0.97, 0.99) | |
| ACR Criteria | | | | |
| Pleuritis/Pericarditis | 0.48 | 0.16 | | 0.003 |
| Pleuritis/Pericarditis vs. No Pleuritis/Pericarditis | | | 2.60 (1.38, 4.87) | |
| Renal Disorder | 0.33 | 0.17 | | 0.05 |
| Renal Disorder vs. No Renal Disorder | | | 1.95 (0.99, 3.83) | |

Table 7: Univariate Time to Hospital Readmission within 30 days

| Characteristic | Hazards Ratio (95% CI) | P- Value |
|---|---|---|
| Age at Baseline | | |
| Per year increase | 1.0 (0.99, 1.01) | 0.96 |
| Median Income within Census Block | | |
| Per one thousand dollar increase | 0.99 (0.98, 0.995) | 0.002 |
| HS Graduates within Census Block | | |
| Per one percent increase | 0.99 (0.97, 1000) | 0.16 |
| Disease Severity | | |
| Per one ACR criteria increase | 1.26 (1.11, 1.42) | 0.0002 |
| Gender | | |
| Female vs. Male | 0.66 (0.38, 1.12) | 0.12 |
| Race | | |
| Black vs. Non-Black | 1.81 (1.03, 3.19) | 0.04 |
| Ethnicity | | 0.64 |
| Hispanic vs. Non- Hispanic | 0.69 (0.17, 2.82) | 0.61 |
| Unknown vs. Non- Hispanic | 0.56 (0.14, 2.28) | 0.42 |
| Marital Status | | 0.81 |
| Divorced vs. Single | 1.18 (0.58, 2.39) | 0.65 |
| Married vs. Single | 1.01 (0.64, 1.60) | 0.97 |
| Separated vs. Single | 0.71 (0.10, 5.16) | 0.73 |
| Widowed vs. Single | 1.51 (0.72, 3.16) | 0.27 |
| Insurance (at time of first visit) | | 0.01 |
| Medicaid vs. Insured | 2.10 (1.26, 3.53) | 0.005 |
| Medicare vs. Insured | 1.95 (1.12, 3.37) | 0.02 |
| Self- pay vs. Insured | 2.02 (1.06, 3.86) | 0.03 |
| Low C3 | | |
| Present vs. Absent | 1.15 (0.73, 1.80) | 0.55 |
| Low C4 | | |
| Present vs. Absent | 0.93 (0.60, 1.46) | 0.76 |
| ACR Criteria | | |
| Malar Rash | | |
| Malar Rash vs. No Malar Rash | 1.29 (0.78, 2.14) | 0.31 |
| Discoid Rash | | |
| Discoid Rash vs. No Discoid Rash | 0.98 (0.55, 1.72) | 0.93 |
| Photosensitivity | | |
| Photosensitivity vs. No Photosensitivity | 0.64 (0.33, 1.23) | 0.18 |
| Oral Ulcer | | |

Table 7: Univariate Time to Hospital Readmission within 30 days

| Characteristic | Hazards Ratio (95% CI) | P- Value |
|---|---|---|
| Oral Ulcers vs. No Oral Ulcers | 1.02 (0.64, 1.65) | 0.92 |
| Non-erosive Arthritis | | |
| Non-erosive Arthritis vs. No Non-erosive Arthritis | 1.02 (0.67, 1.54) | 0.94 |
| Pleuritis or Pericarditis | | |
| Pleuritis or Pericarditis vs. No Pleuritis or Pericarditis | 2.23 (1.48, 3.37) | 0.0001 |
| Renal Disorder | | |
| Renal Disorder vs. No Renal Disorder | 1.87 (1.25, 2.81) | 0.002 |
| Neurologic Disorder | | |
| Neurologic Disorder vs. No Neurologic Disorder | 1.58 (0.89, 2.83) | 0.13 |
| Hematologic Disorder | | |
| Hematologic Disorder vs. No Hematologic Disorder | 1.88 (0.95, 3.74) | 0.07 |
| Immunologic Disorder | | |
| Immunologic Disorder vs. No Immunologic Disorder | 1.18 (0.75, 1.86) | 0.48 |
| Positive Antinuclear Antibody | | |
| Positive Antinuclear Antibody vs. No Positive Antinuclear Antibody | 2.74 (0.68, 11.09) | 0.16 |

Table 8: Multivariable Cox Regression Hazards of Time to Hospital Readmission within 30 days

| Parameter | Parameter Estimate | Standard Error | Hazards Ratio (95% CI) | P-value |
|---|---|---|---|---|
| Median Income within Census Block | -0.01 | 0.005 | | 0.003 |
| Per one thousand dollar increase | | | 0.99 (0.98, 0.995) | |
| ACR Criteria | | | | |
| Pleuritis or Pericarditis | 0.69 | 0.23 | | 0.002 |
| Pleuritis or Pericarditis vs. No Pleuritis or Pericarditis | | | 2.00 (1.29, 3.12) | |

Table 9: Kaplan Meier Time to Readmission Quartile Estimates

| Percent | Point Estimate | 95% Confidence Interval [Lower, Upper] | |
|---|---|---|---|
| 75 | 18 | 15 | 22 |
| 50 | 8 | 5 | 11 |
| 25 | 2 | 0 | 4 |

Table 9a: Time to readmission for those that were readmitted by ICD 9 code

| | N | Mean | Std Dev | Median | Q1, Q3 | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| Overall | 96 | 10.42 | 9.17 | 8.0 | 2.0, 18.0 | 0 | 29.0 |
| Same Principal ICD 9 code | 18 | 8.83 | 7.00 | 8.0 | 2.0, 21.0 | 0 | 22.0 |
| Different Principal ICD 9 code | 78 | 10.78 | 9.60 | 8.5 | 2.0, 16.0 | 0 | 29.0 |

| Table 10: Final Cohort Included in Analysis | | | | |
|---|---|---|---|---|
| **SLE INCIDENT N = 343** | | | | |
| ***Restrictions*** | **Hospital Discharge Data** | | **No Hospital Discharge Data** | |
| Original Dataset | **N = 307** | | **N = 36** | |
| | ER, etc. | Hospital only | | Never Admit |
| *Hospital Restriction* | 54 | 253 | *Hospital Restriction does not apply* | 36 |
| Number of people moved to **No Hospital Discharge Data** because all *hospital* visits were before date of diagnosis | **N= 18** | | **-** | |
| **SLE INCIDENT** *with hospital visits after diagnosis* **N = 343** | | | | |
| Original Dataset | **N = 289** | | **N = 54** | |
| | ER, etc. | Hospital only | | Never Admit |
| *Hospital Restriction* | 54 | 235 | *Hospital Restriction does not apply* | 54 |
| | Hospital Only N = 235 | | Never Admit N = 54 | |
| | 17 or younger | 18 + | 17 or younger | 18 + |
| *Age restriction* | 21 | 214 | 2 | 52 |
| | Hospitalized Not readmitted within 30 days | Hospitalized Readmitted within 30 days | | Never hospitalized |
| **Final Dataset** | **118** | **96** | | **52** |

| Table 11: Most Common Principal ICD 9 Code at First Hospital Visit by Group | | | | |
|---|---|---|---|---|
| **Count<br>Overall %<br>Row %<br>Col %** | | **Hospitalized with no readmission within 30 days** | **Hospitalized with readmission within 30 days** | **Total** |
| **Principal ICD 9 Code at First Hospital Visit** | **Label of First Principal ICD 9 Code at First Hospital Visit** | | | |
| **218.1** | **Intramural leiomyoma of uterus** | 4 | 0 | 4 |
| | | 1.87 | 0 | 1.87 |
| | | 100 | 0 | |
| | | 3.39 | 0 | |
| **282.62** | **Sickle Cell** | 0 | 3 | 3 |
| | | 0 | 1.4 | 1.4 |
| | | 0 | 100 | |
| | | 0 | 3.13 | |
| **284.8** | **Other specified aplastic anemias** | 1 | 2 | 3 |
| | | 0.47 | 0.93 | 1.4 |
| | | 33.33 | 66.67 | |
| | | 0.85 | 2.08 | |
| **415.19** | **Other pulmonary embolism and infarction** | 2 | 3 | 5 |
| | | 0.93 | 1.4 | 2.34 |
| | | 40 | 60 | |
| | | 1.69 | 3.13 | |
| **423.9** | **Unspecified disease of pericardium** | 2 | 1 | 3 |
| | | 0.93 | 0.47 | 1.4 |
| | | 66.67 | 33.33 | |
| | | 1.69 | 1.04 | |
| **428** | **Heart failure** | 2 | 2 | 4 |
| | | 0.93 | 0.93 | 1.87 |
| | | 50 | 50 | |
| | | 1.69 | 2.08 | |
| **486** | **Pneumonia, organism unspecified** | 4 | 3 | 7 |
| | | 1.87 | 1.4 | 3.27 |
| | | 57.14 | 42.86 | |
| | | 3.39 | 3.13 | |
| **511.9** | **Unspecified pleural effusion** | 2 | 2 | 4 |
| | | 0.93 | 0.93 | 1.87 |
| | | 50 | 50 | |
| | | 1.69 | 2.08 | |
| **584.9** | **Acute kidney failure, unspecified** | 1 | 2 | 3 |
| | | 0.47 | 0.93 | 1.4 |
| | | 33.33 | 66.67 | |

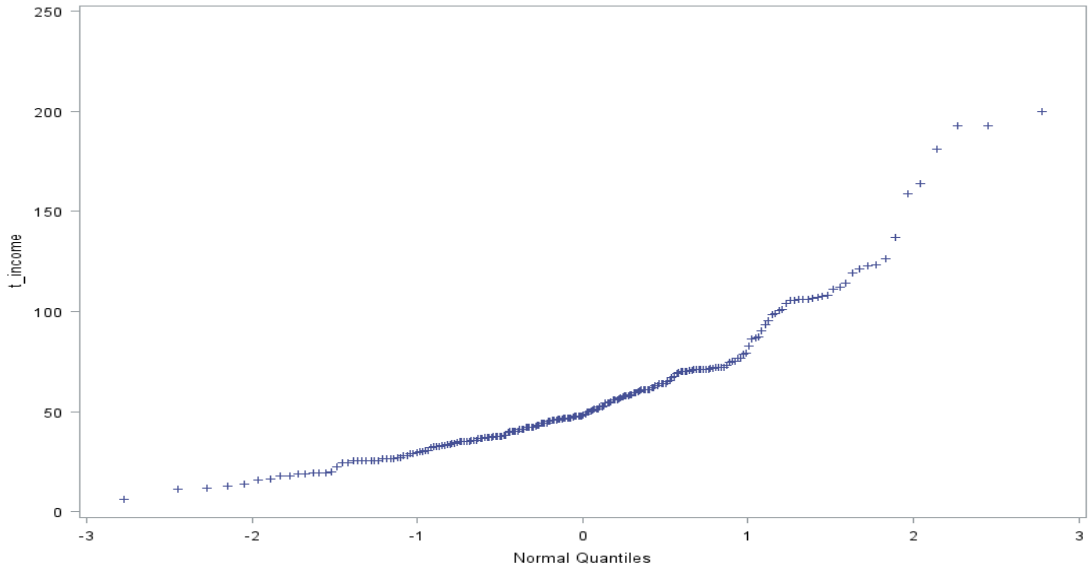
| Table 11: Most Common Principal ICD 9 Code at First Hospital Visit by Group | | | | |
|---|---|---|---|---|
| **Count**<br>**Overall %**<br>**Row %**<br>**Col %** | | **Hospitalized with no readmission within 30 days** | **Hospitalized with readmission within 30 days** | **Total** |
| | | 0.85 | 2.08 | |
| **644.21** | **Early onset of delivery, delivered, with or without mention of antepartum condition** | 3 | 0 | 3 |
| | | 1.4 | 0 | 1.4 |
| | | 100 | 0 | |
| | | 2.54 | 0 | |
| **659.71** | **Abnormality in fetal heart rate or rhythm, delivered, with or without mention of antepartum condition** | 1 | 2 | 3 |
| | | 0.47 | 0.93 | 1.4 |
| | | 33.33 | 66.67 | |
| | | 0.85 | 2.08 | |
| **710** | **Systemic lupus erythematosus** | 14 | 9 | 23 |
| | | 6.54 | 4.21 | 10.75 |
| | | 60.87 | 39.13 | |
| | | 11.86 | 9.38 | |

**Table 12: Example of Determining End of Interval for Readmission Date**

| ID | Admission Date | Discharge Date | End of Interval for Readmission Date | 30 days from Last Date of Discharge | Admitted to Hospital (y/n) | Readmitted to Hospital within 30 days (y/n) | Ever Readmitted to Hospital within 30 days (y/n) | Ever Readmitted to Hospital within 30 days Label |
|---|---|---|---|---|---|---|---|---|
| 0119 | 11/27/2006 | 12/2/2006 | 1/1/2007 | 12/28/2003 | 1 | 0 | 0 | Hospitalized with no readmission within 30 days |
| 0119 | 12/28/2006 | ***1/4/2007*** | 1/1/2007 | 1/1/2007 | 0 | 1 | 1 | Hospitalized with readmission within 30 days |
| 0119 | 2/2/2007 | 2/5/2007 | ***2/3/2007*** | 2/3/2007 | 0 | 1 | 1 | Hospitalized with readmission within 30 days |
| 0119 | 12/29/2008 | 1/9/2009 | 1/23/2009 | 1/23/2009 | 0 | 1 | 1 | Hospitalized with readmission within 30 days |
| 0119 | 1/20/2009 | ***1/26/2009*** | 1/23/2009 | 2/8/2009 | 0 | 1 | 1 | Hospitalized with readmission within 30 days |
| 0119 | 2/17/2009 | ***2/19/2009*** | ***2/25/2009*** | 2/25/2009 | 0 | 1 | 1 | Hospitalized with readmission within 30 days |
| 0119 | 3/11/2009 | 3/12/2009 | ***3/21/2009*** | 3/21/2009 | 0 | 1 | 1 | Hospitalized with readmission within 30 days |
| 0119 | 1/28/2010 | 2/8/2010 | 3/10/2010 | 4/11/2009 | 1 | 0 | 1 | Hospitalized with readmission within 30 days |
| 0143 | 7/26/2013 | 8/8/2013 | 9/7/2013 | 3/22/2013 | 1 | 0 | 0 | Hospitalized with no readmission within 30 days |
| 0143 | 8/12/2013 | ***8/16/2013*** | 9/7/2013 | 9/7/2013 | 0 | 1 | 1 | Hospitalized with readmission within 30 days |
| 0143 | *9/19/2013* | 9/22/2013 | ***10/22/2013*** | *9/15/2013* | 1 | 0 | 1 | Hospitalized with readmission within 30 days |

### *6.2 Figures*

**Figure:** Q-Q plot Income scaled by 1000



***SAS CODE***

```
libname x "H:\SAS 9.4\Grady\Hospital Discharge\Data" ;
libname r "H:\SAS 9.4\Grady\Hospital Discharge\Raw Data" ;

%macro age(date,birth);
floor ((intck('month',&birth,&date)
- (day(&date) < day(&birth))) / 12)
%mend age;

data work.geo;
        set r.overall_geocode_2011_2012;

        if bgMedIncFm= -99999 then bgMedIncFm= .;
        if bgMedIncHs= -99999 then bgMedIncHs= .;
        if bgPrpInc= -99999 then bgPrpInc= .;
        if bgPrpHSdg= -99999 then bgPrpHSdg= .;
        if bgPrpHSdg= -9999900.00 then bgPrpHSdg = .;
        if bgPrpHSdgM= -99999 then bgPrpHSdgM= .;
        if bgPrpHSdgF= -99999 then bgPrpHSdgF= .;
        propgradhs=bgPrpHSdg*100;
        keep
                recno
                propgradhs
                bgMedIncFm
                bgMedIncHs
                bgPrpInc
                bgPrpHSdg
                bgPrpHSdgM
                bgPrpHSdgF;
        rename glr_recno = recno;
run;



proc sql;
        create table glrgeo as
  select *
    from x.glrinfo_mt as l
                left join
       work.geo as m
    on l.recno=m.recno
        where county2002 = 1 or county2002 = 2 or county2003 = 1 or county2003 = 2 or county2004 = 1 or county2004 = 2 ;
;
quit;

proc sort data=r.hddata_may2015;
by trackid;
run;

data work.hospitaldata;
        set r.hddata_may2015;

                check_admissiondate = admissiondate;
 first_adm_age= %age(admissiondate, glr_dob);


        if LENGTH_OF_STAY= -1 then LENGTH_OF_STAY= .;
        if TOTAL_CHARGES= -1 then TOTAL_CHARGES=.;
        if PAYOR_LABEL= "Unknown" then PAYOR_LABEL="" ;
        if DISCHARGE_STATUS_LABEL= "Unknown" then DISCHARGE_STATUS_LABEL= "" ;

                addate= put( admissiondate, mmddyy10.) ;
```

```
                monthad = scan (addate, 1, '/')+ 0;
                dayad = scan (addate, 2, '/') + 0;
                yrad = scan (addate, 3, '/') + 0;

                season = 0;
*winter 12/22-03/20 unless it's 2007 or 2011 then it's 12/22-3/20;

                        if 01 le monthad lt 03 & 01 le dayad le 31 then season = 1;
                                *if 02 le monthad lt 03 & 01 le dayad le 29 then season = 1;
                                        if 03 le monthad lt 04 & 01 le dayad le 19 then season =1;
                                                if monthad = 12 & dayad ge 21 then season = 1;

*spring 3/21-6/20 unless it's 2008 or 2012 then it's 3/20-6/20;
                *if yrad = 2008 | yrad = 2012 & monthad = 6 & dayad = 20 then season = 2;
                        if 3 le monthad lt 4 & dayad ge 20 then season = 2;
                                if 4 le monthad lt 6 & 01 le dayad le 31 then season = 2;
                                        if monthad = 6 & 01 le dayad le 20 then season = 2;
*summer 6/21-9/22;
                        if monthad = 06 & dayad ge 21 then season = 3;
                                if 07 le monthad lt 9 & 01 le dayad le 31 then season = 3;
                                        if monthad = 9 & 01 le dayad le 21 then season = 3;

*fall 9/23 - 12/21;
                        if 09 le monthad lt 10 & dayad ge 22 then season = 4;
                                if 10 le monthad lt 12 & 01 le dayad le 31 then season = 4;
                                        if monthad = 12 & dayad le 20 then season = 4;

*adjusts for the change in the days of the solstice by year;
                if  yrad = 2007 | yrad = 2011 & monthad = 12 & dayad = 21 then season = 4;
                if  yrad = 2006 | yrad = 2007 | yrad = 2011 & monthad = 9 & dayad = 22 then season = 3;
                if  yrad = 2008 | yrad = 2011 & monthad = 6 & dayad = 20 then season = 3;

                        winter = 0;
                        spring = 0;
                        summer = 0;
                        autumn = 0;
                        if season = 1 then winter = 1;
                        if season = 2 then spring = 1;
                        if season = 3 then summer = 1;
                        if season = 4 then autumn = 1;
                        seasonl = season;
        admission_check = event_place_type_label;
format  seasonl seasons_. check_admissiondate mmddyy10.;

run;


data work.glr_diag;
        set work.glrgeo;
        keep trackid dtofdiag county2002 county2003 county2004 baseage;
run;

proc sort data = work.glr_diag;
        by trackid;
run;
proc sort data = work.hospitaldata;
        by trackid admissiondate;
run;


data work.hd_dd;
        merge work.hospitaldata glr_diag;
```

```
        by trackid;
        if event_place_type= 1 then place = 1;
                else if event_place_type = . then place = 888;
                        else place = 9;

run;

data work.temp1;
        set work.hd_dd;
        by trackid;
         where (county2002 in (1, 2) or county2003 in (1, 2) or county2004 in (1, 2) )  ;
         if glr_sle = . then delete;
        if last.trackid;
run;

*number of sle patients with HDD data;
proc freq data = work.temp1;
        tables glr_sle;
run;


data work.hd_diag ;
        set work.hd_dd;
                if admissiondate > 0 and dtofdiag > admissiondate then check = 1;
                if dtofdiag > admissiondate and dtofdiag <eventdate then check = .;
        *if admissiondate > 0 and dtofdiag > admissiondate then output removed;
        *       else output hd_diag;
        drop county2002 county2003 county2004;
        format dtofdiag mmddyy10.;
run;
/* to get the number of people who were moved to "no hospital discharge data" you need to
comment out the drop statement above*/

/*
proc sort data = work.hd_diag;
        by trackid admissiondate;
run;

data work.temp2;
        set work.hd_diag;
        by trackid;
         where (county2002 in (1, 2) or county2003 in (1, 2) or county2004 in (1, 2) )  ;
         if glr_sle = . then delete;
        if last.trackid;
run;

proc freq data = work.temp2;
        tables check;
run;
*/

proc sql;
        create table glrgro_hdd as
  select *
    from glrgeo as l
                left join
       work.hd_diag as m
    on l.trackid=m.trackid
        where county2002 = 1 or county2002 = 2 or county2003 = 1 or county2003 = 2 or county2004 = 1 or county2004 = 2 ;
quit;
```

```
data a;
*work.glrgro_hdd is a dataset that combines the glr
complete dataset with the geocoded dataset with the hospital
discharge dataset. the only restriction on work.glrgro_hdd is
that the patients must have lived in Fulton or Dekalb county
at one point between 2002 - 2004;

        set work.glrgro_hdd;
        by trackid;

*the following step immediately requires this dataset to be
limited to GLR SLE Incident patients only;

        where glr_sle = 1; *n = 343;
run;

proc print data = work.a;
        where dtofdiag > admissiondate and dtofdiag <eventdate ;
        var trackid dtofdiag admissiondate eventdate;
run;

data work.temp3;
        set work.a;
        by trackid;
        if last.trackid;
run;
*total number of glr_sle patients;
proc freq data = work.temp3;
        tables glr_sle;
run;

data work.b;
        set work.a;
        by trackid;
                if place = 888 & admissiondate = . then original_admit = 0;*never admit (m) = 36;
                else original_admit = 1; *admit (n)= 307;

                if check = 1 then original_admit = 888;
                if original_admit = 888 then admissiondate = .;
run;
proc freq data = work.b;
        tables check;
run;
proc sort data = work.b;
        by trackid admissiondate;
run;

data work.temp4;
        set work.b;
        by trackid;
        if last.trackid;
run;
*original admit (0) means no hospital discharge data (n = 36)
original admit (1) means has hospital discharge data (n = 299)
original admit (888) means has hospital discharge data with all admissions before date of diagnosis (n = 8)
please note that when you restrict to hospital visits only, this (888) the size will increase
;
proc freq data = work.temp4;
        tables original_admit;
run;

data work.c;
```

```
        set work.b;
        where EVENT_PLACE_TYPE = 1;
        by trackid;
run;


proc sort data = work.c;
        by trackid admissiondate eventdate;
run;




proc sql;
  create table c2 as
  select * from b
  where TrackID not in(select TrackID from c);
quit;

data work.c3;
        set work.c2;
                where EVENT_PLACE_TYPE ne .;
        run;

proc sort data = work.c3 nodupkey out=temp5;
by trackid ;
run;


*this is the number of people only have visits outside of the hospital;
proc freq data = work.temp5;
        tables EVENT_PLACE_TYPE;
run;


proc sql;
  create table temp6 as
  select * from  c
  where TrackID not in(select TrackID from temp5);
quit;

proc sort data = work.temp6 nodupkey;
by trackid;
run;

proc freq data = work.temp6;
        tables EVENT_PLACE_TYPE;
run;

data work.d3;
        set work.c;
        by trackid;
                        if admissiondate > 0 then admit = 1; *300;
                        else admit = 5;
                        keep trackid admit place dtofdiag admissiondate eventdate place event_place_type
event_place_type_label original_admit check ;
run;


proc sort data = work.d3;
        by trackid admissiondate;
run;
```

```
data work.temp7;
        set work.d3;
        by trackid;
        if last.trackid;
run;
proc print data = work.temp7;
where admit = 5;
        var trackid admissiondate admit original_admit;
run;
*admit (5) is the number of people moved to No Hospital Discharge
Data because all of their hospital visits were before date of diagnosis;
proc freq data = work.temp7;
        tables admit;
run;


data work.d5;
        merge b work.d3;
        where place ne 9 ;
        by trackid;
        if admit = 5 then place = 888;
        if place = 1 then neveradmit = 0;
                else neveradmit = 1;

        if baseage ge 18 then adult = 1;
        else adult = 0;
run;

proc sort data = work.d5;
        by trackid admissiondate;
run;
data work.temp8;
        set work.d5;
        by trackid;
        if last.trackid;
run;

*neveradmit (0) is the total number of hospital visits
neveradmit (1) is the total number of "No hospital discharge data"

admit (1) is the total number of hospital visits
admit (5) is the number of people moved to No Hospital Discharge
Data because all of their hospital visits were before date of diagnosis
admit (.) the orginial number of people that have no hospital discharge data
;
proc freq data = work.temp8;
        tables neveradmit admit adult*neveradmit;
run;

*
neveradmit (1) , n = 54
neveradmit (5) , n = 235

neveradmit (1) and 18 + yrs , n = 52
neveradmit (5) and 18 + yrs , n = 217
;


data work.thesis;
        set work.d5;
        by trackid;
                where adult = 1;
```

```
run;



proc sort data = work.thesis;
        by trackid admissiondate;
run;

data work.admission_thesis;
        set work.thesis;
        by trackid;

        where place = 1;

                *count the number of visits per patient;
                 visit + 1;
                 if first.trackid then visit = 1;
/************************CODE FOR ADMISSION AND READMISSION**********************/

                        retain newdate30 delayevent30 ;
                        admission30 = 0;
                        readmission30 = 0;
                        delayevent30 = lag(eventdate) + 30;

        format newdate30 mmddyy10. delayevent30 mmddyy10. ;

                        *30day admission and readmission calculcation;
                                if first.trackid then do
                                                                        admission30 = 1;
                                                                        readmission30 = 0;
                                                                        newdate30 = eventdate + 30;
                                                                        delayevent30 = .;

                                                                end;
                                else if admissiondate <= newdate30 then readmission30 = 1;
                                else if admissiondate > (newdate30) & admissiondate <= delayevent30 then do

                                                                                readmission30 = 1;

                                                                                newdate30 =
delayevent30;

                                                                        end;
                                else if admissiondate > (newdate30) & admissiondate > delayevent30 then do

                                                                                admission30 = 1;

                                                                                newdate30 =
eventdate + 30;

                                                                        end;
                                        else do
                                                        admission30 = 1;
                                                        readmission30 = 0;
                                                        newdate30 = eventdate + 30;
                                                end;

                                *sum all 30 readmissions per patient;
                                if first.trackid then sumreadmission30=0 ;
                                sumreadmission30 + readmission30;
                                *sum all 30 admissions per patient;
                                if first.trackid then sumadmission30=0 ;
```

```
                                        sumadmission30 + admission30;

                                        *30day readmission yes/no if there are any readmissions greater than 1 by patient;
                                        rd30 = 0;
                                        if sumreadmission30 > 0 then rd30= 1;
                        *end;
*creating variables to serve for labels for the readmission coding;
                                        admission30l=admission30;
                                        readmission30l=readmission30;
                                        rd30l=rd30;

        format
                        admission30l admission_.
                        readmission30l readmission30_.
                        rd30l rd30_.

;
keep trackid visit dtofdiag first_adm_age length_of_stay payor payor_label total_charges admission30 admission30l
readmission30 readmission30l rd30 rd30l admissiondate newdate30 sumreadmission30 readmission30 sumadmission30
eventdate delayevent30 event_place_type_label admit
recordid;
run;

proc sort data = work.admission_thesis;
        by trackid admissiondate;
run;

data work.temp10;
        set work.admission_thesis;
        by trackid;
        if last.trackid;
run;

*based on hospital admissions only,
rd30 (0) is the number of people that were hospitalized but had no readmission with 30 days, n = 119
rd30 (1) is the number of people that were hospitalized but were readmission with 30 days, n = 98
;
proc freq data = work.temp10;
        tables rd30;
run;

data work.tt;
        set work.admission_thesis;
        by trackid;
        retain first_adm_date first_age first_length_of_stay first_charge insurance insurance_label;
        if first.trackid then do;
                                                                first_adm_date = admissiondate;
                                                                first_age = first_adm_age;
                                                                first_length_of_stay = length_of_stay;
                                                                first_charge = total_charges;
                                                                insurance = payor;
                                                                insurance_label = payor_label;
                                                        end;
        if insurance in (2, 8, 7, 17, 16) then insur_stat = 1;
        if insurance in (6, 4, 5, 1) then insur_stat = 2;
        if insurance in (10, 14) then insur_stat = 3;
        if insurance = 13 then insur_stat = 4;
        if insurance in (12, 3) then insur_stat = 5;

        insur_stat_label = insur_stat;

        format first_adm_date mmddyy10. insur_stat_label insur_.;
```

```
drop admissiondate eventdate;
run;

proc sql;
        create table thesis_tot as
  select *
    from thesis as l
                left join
      work.tt as m
    on l.trackid=m.trackid and l.recordid = m.recordid;
quit;

proc sort data = work.thesis_tot;
        by trackid admissiondate;
run;


data work.rd;
        set work.thesis_tot;
        by trackid;
        where rd30 = 1;
        if first.trackid then do;
                                                timedate = admissiondate;
                                                first_readmit = 1;
                                        end;
format timedate mmddyy10.;
run;


proc sql;
        create table lager as
  select *
    from work.thesis_tot as l
                left join
      work.rd as m
    on l.trackid=m.trackid and l.recordid = m.recordid;
quit;

proc sort data = work.lager;
by trackid admissiondate eventdate;
run;
data work.surv_rd;
        set work.lager;
        by trackid;

        retain dischargedate readmitdate first_icd old_icd icd_group;
        teller = lag(readmission30);
        tellerdate = lag(eventdate);
        previous_icd = lag(PRINCIPAL_ICD_9_DIAGNOSIS);

        if first_readmit= 1 and teller = 0 then do;
                                                                        old_icd =
previous_icd;

        dischargedate = tellerdate;
                                                                end;
        dischargedate + 0 ;
        if first_readmit = 1 and old_icd > 0 then do;
                                                                        first_icd
= PRINCIPAL_ICD_9_DIAGNOSIS;

        readmitdate = timedate;
```

```
                                                                                                    end;

        if old_icd = first_icd then icd_group = 0;
                else if old_icd ne first_icd then icd_group = 1;



        time_length = readmitdate - dischargedate;


        if rd30 ne 1 then icd_group = .;
        if rd30 ne 1  then old_icd = .;
        if rd30 ne 1  then first_icd = "" ;
        if rd30 ne 1  then readmitdate = .;
        if rd30 ne 1  then dischargedate = .;
        if rd30 ne 1  then time_length = .;

        icd_group_label = icd_group;

        if last.trackid and rd30 = 0 then time_length = 30;

        format readmitdate mmddyy10. dischargedate mmddyy10. icd_group_label icd_group_.;
        drop tellerdate previous_icd timedate ;
run;

data work.final_thesis_data;
        set work.surv_rd;
        by trackid;

        length m_status $ 30;

        if sex = 2 then gender = "Female" ;
        if sex = 1 then gender = "Male" ;

        if race = 3 then race_l= "Black or African-American" ;
        if race = 1 then race_l = "Asian" ;
        if race = 2 then race_l = "Multiracial" ;
        if race = 5 then race_l = "White" ;

        if maritalstat = 1 then m_status = "Single" ;
        if maritalstat = 2 then m_status = "Married" ;
        if maritalstat = 3 then m_status = "Separated" ;
        if maritalstat = 4 then m_status = "Divorced" ;
        if maritalstat = 5 then m_status = "Widowed" ;
        if maritalstat = 9 then m_status = "Unknown" ;

        if trackid = "HDD2015_0497" or trackid = "HDD2015_2384" or trackid = "HDD2015_2467" then m_status =
"Married" ;
        if trackid = "HDD2015_0572" or trackid = "HDD2015_1231" then m_status = "Divorced" ;
        if trackid = "HDD2015_0578" or trackid = "HDD2015_2020" then m_status = "Single" ;
        if trackid = "HDD2015_2572" or trackid = "HDD2015_2964" then m_status = "Widowed" ;


        if m_status = "Married" then m_status_num = 1;
        if m_status = "Divorced" then m_status_num = 2;
        if m_status = "Single" then m_status_num = 3;
        if m_status = "Widowed" then m_status_num = 4;

        if spanorig ne 99 and spanorig ne 9 and spanorig > 0 then span = 1;
        if spanorig = 0 then span = 0;
        if spanorig = 99 or spanorig = 9 then span = 99;
```

```
        if span = 0 then eth_label = "Non- Hispanic" ;
        if span = 1 then eth_label = "Hispanic" ;
        if span = 99 then eth_label = "Unknown" ;

        if place = 888 then do ;
                                                admissiondate = .;
                                                first_adm_date = .;
                                                first_age = .;
                                                first_adm_age = .;
                                                first_length_of_stay = .;
                                                first_charge = .;
                                                insurance = .;
                                                insurance_label = "" ;
                                                admission30 = .;
                                                readmission30 = .;
                                                rd30 = .;
                                        end;

        if rd30 = 0 then base_cat = 0;
                else if rd30 = 1 then base_cat = 1;
                        else base_cat = 999;
        base_cat_label = base_cat;

        if base_cat in (0,1) then hospitalized = 1;
                else hospitalized = 0;
        if hospitalized = 1 then hospital_label = "Hospitalized" ;
                else hospital_label = "Never hospitalized" ;

        if lowc3 = 9 then lowc3 = .;
        if lowc4 = 9 then lowc4 = .;

        low3_label = lowc3;
        low4_label = lowc4;

format base_cat_label cat. low3_label lowc3_. low4_label lowc4_.;

run;

proc sort data = final_thesis_data out= x.final_thesis_data_surv;
        by trackid admissiondate eventdate;
run;



data work.single;
        set x.final_thesis_data_surv;
        by trackid;
        if last.trackid;
run;


**************************END*****************************;

***************FACTORS/ UNIVARIATE /MULTIVARIABLE CODE;

ods rtf file = "H:\SAS 9.4\Grady\Hospital Discharge\Output\Univariate Hospital Logistic 032016.rtf";

PROC LOGISTIC DATA= work.single;
        class gender(ref = "Male" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = gender/clodds = wald;
RUN;
```

```
PROC LOGISTIC DATA= work.single;
        class race_l(ref = "White" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = race_l/clodds = wald;
RUN;

PROC LOGISTIC DATA= work.single;
        class eth_label(ref = "Non- Hispanic" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = eth_label/clodds = wald;
RUN;

PROC LOGISTIC DATA= work.single;
        class m_status(ref = "Single" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = m_status/clodds = wald;
RUN;

PROC LOGISTIC DATA= work.single;
        class insur_stat_label(ref = "Insured" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = insur_stat_label/clodds = wald;
RUN;

PROC LOGISTIC DATA= work.single;
        class low3_label(ref = "Negative" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = low3_label/clodds = wald;
RUN;

PROC LOGISTIC DATA= work.single;
        class low4_label(ref = "Negative" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = low4_label/clodds = wald;
RUN;

PROC LOGISTIC DATA= work.single;
        class Crit1l(ref = "No Malar Rash" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = Crit1l/clodds = wald;
RUN;

PROC LOGISTIC DATA= work.single;
        class Crit2l(ref = "No Discoid Rash" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = Crit2l/clodds = wald;
RUN;

PROC LOGISTIC DATA= work.single;
        class Crit3l(ref = "No Photosensitivity" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = Crit3l/clodds = wald;
RUN;

PROC LOGISTIC DATA= work.single;
        class Crit4l(ref = "No Oral Ulcers" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = Crit4l/clodds = wald;
RUN;

PROC LOGISTIC DATA= work.single;
        class Crit5l(ref = "No Non-erosive Arthritis" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = Crit5l/clodds = wald;
RUN;

PROC LOGISTIC DATA= work.single;
        class Crit6l(ref = "No Pleuritis or  Pericarditis" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = Crit6l/clodds = wald;
RUN;
```

```
PROC LOGISTIC DATA= work.single;
        class Crit7l(ref = "No Renal Disorder" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = Crit7l/clodds = wald;
RUN;

PROC LOGISTIC DATA= work.single;
        class Crit8l(ref = "No Neurologic Disorder" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = Crit8l/clodds = wald;
RUN;

PROC LOGISTIC DATA= work.single;
        class Crit9l(ref = "No Hematologic Disorder" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = Crit9l/clodds = wald;
RUN;


PROC LOGISTIC DATA= work.single;
        class Crit10l(ref = "No Immunologic Disorder" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = Crit10l/clodds = wald;
RUN;

PROC LOGISTIC DATA= work.single;
        class Crit11l(ref = "No Positive Antinuclear Antibody" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = Crit11l/clodds = wald;
RUN;

******END OF CAT;



*begin numerical;
PROC LOGISTIC DATA= work.single;
        model rd30l (event = "Hospitalized with readmission within 30 days") = baseage/clodds = wald;
        unit baseage = 1;
RUN;

PROC LOGISTIC DATA= work.single;
        model rd30l (event = "Hospitalized with readmission within 30 days") = bgMedIncFm/clodds = wald;
        unit bgMedIncFm = 10000;
RUN;

PROC LOGISTIC DATA= work.single;
        model rd30l (event = "Hospitalized with readmission within 30 days") = propgradhs/clodds = wald;
        unit propgradhs = 1;
RUN;

PROC LOGISTIC DATA= work.single;
        model rd30l (event = "Hospitalized with readmission within 30 days") = acrcrit/clodds = wald;
        unit acrcrit = 1;
RUN;

PROC LOGISTIC DATA= work.single;
        model rd30l (event = "Hospitalized with readmission within 30 days") = first_age/clodds = wald;
        unit first_age = 1;
RUN;

PROC LOGISTIC DATA= work.single;
        model rd30l (event = "Hospitalized with readmission within 30 days") = first_length_of_stay/clodds = wald;
        unit first_length_of_stay = 1;
RUN;
```

```
PROC LOGISTIC DATA= work.single;
	model rd30l (event = "Hospitalized with readmission within 30 days") = first_charge/clodds = wald;
	unit first_charge = 1000;
RUN;


PROC LOGISTIC DATA= work.single;
	model rd30l (event = "Hospitalized with readmission within 30 days") = visit/clodds = wald;
	unit visit = 1;
RUN;

*end ;


proc means data = work.single n mean std median qrange min max maxdec=1;
	where rd30 = 1;
	var time_length;
run;

ods rtf close;


data work.analysis;
	set x.final_thesis_data_surv;
	by trackid;
	marital_analysis= m_status;
	if m_status = "Unknown" then marital_analysis = "";
	length race_analysis $ 20;
	if race_l = "Black or African-American" then race_analysis = "Black";
		else race_analysis = "Non-Black";
	insurance_analysis = insur_stat_label;
		if insur_stat_label = 5 then insurance_analysis = .;
	t_income = bgMedIncFm/1000;
	if last.trackid;
	format insurance_analysis insur_.;
run;

ods rtf file= "\\Client\H$\Desktop\Update Hospital Descriptive.rtf";

proc freq data = work.analysis;
	tables insurance_analysis*rd30l/chisq;
run;


proc logistic data = work.analysis;
	class race_analysis (ref = "Non-Black");
	model rd30l (event = "Hospitalized with readmission within 30 days") = race_analysis;
run;

proc logistic data = work.analysis;
	class marital_analysis (ref = "Single");
	model rd30l (event = "Hospitalized with readmission within 30 days") = marital_analysis;
run;

proc logistic data = work.analysis;
	class insurance_analysis (ref = "Insured");
	model rd30l (event = "Hospitalized with readmission within 30 days") = insurance_analysis;
run;
ods rtf close;

ods rtf file= "\\Client\H$\Desktop\Multivariate Hospital Descriptive 032316.rtf";
/*
```

```
proc logistic data = work.analysis;
	model rd30l (event = "Hospitalized with readmission within 30 days") = bgMedIncFm;
	unit bgMedIncFm = 1;
run;
*/
proc logistic data = work.analysis;
	class gender(ref = "Male" ) race_analysis (ref = "Non-Black") insurance_analysis (ref = "Insured") Crit3l(ref = "No Photosensitivity" ) Crit6l(ref = "No Pleuritis or  Pericarditis" ) Crit7l(ref = "No Renal Disorder" ) Crit8l(ref = "No Neurologic Disorder" ) Crit9l(ref = "No Hematologic Disorder" ) Crit10l(ref = "No Immunologic Disorder" );
	model rd30l (event = "Hospitalized with readmission within 30 days") = t_income propgradhs  gender race_analysis insurance_analysis Crit3l Crit6l Crit7l Crit8l Crit9l Crit10l/selection = forward slentry = 0.05;
	unit t_income = 1 propgradhs = 1 ;
run;

proc logistic data = work.analysis;
	class gender(ref = "Male" ) race_analysis (ref = "Non-Black") insurance_analysis (ref = "Insured") Crit3l(ref = "No Photosensitivity" ) Crit6l(ref = "No Pleuritis or  Pericarditis" ) Crit7l(ref = "No Renal Disorder" ) Crit8l(ref = "No Neurologic Disorder" ) Crit9l(ref = "No Hematologic Disorder" ) Crit10l(ref = "No Immunologic Disorder" );
	model rd30l (event = "Hospitalized with readmission within 30 days") = t_income propgradhs gender race_analysis insurance_analysis Crit3l Crit6l Crit7l Crit8l Crit9l Crit10l/selection = backward slstay = 0.05;
	unit t_income = 1 propgradhs = 1 ;
run;


proc logistic data = work.analysis;
	class gender(ref = "Male" ) race_analysis (ref = "Non-Black")  Crit3l(ref = "No Photosensitivity" ) Crit6l(ref = "No Pleuritis or  Pericarditis" ) Crit7l(ref = "No Renal Disorder" ) Crit8l(ref = "No Neurologic Disorder" ) Crit9l(ref = "No Hematologic Disorder" ) Crit10l(ref = "No Immunologic Disorder" );
	model rd30l (event = "Hospitalized with readmission within 30 days") = t_income propgradhs gender race_analysis Crit3l Crit6l Crit7l Crit8l Crit9l Crit10l/selection = backward slstay = 0.05;
	unit t_income = 1 propgradhs = 1 ;
run;


proc logistic data = work.analysis;
	class Crit6l(ref = "No Pleuritis or  Pericarditis" ) Crit7l(ref = "No Renal Disorder" );
	model rd30l (event = "Hospitalized with readmission within 30 days") = t_income Crit6l Crit7l;*/selection = backward slstay = 0.05;
	unit t_income = 1;
run;



proc logistic data = work.analysis;
	class Crit6l(ref = "No Pleuritis or  Pericarditis" );* Crit7l(ref = "No Renal Disorder" );
	model rd30l (event = "Hospitalized with readmission within 30 days") = t_income Crit6l;* Crit7l;*/selection = backward slstay = 0.05;
	unit t_income = 1;
run;

ods rtf close;

proc logistic data = work.analysis;
	class Crit6l(ref = "No Pleuritis or  Pericarditis" );* Crit7l(ref = "No Renal Disorder" );
	model rd30l (event = "Hospitalized with readmission within 30 days") = bgMedIncFm Crit6l;* Crit7l;*/selection = backward slstay = 0.05;
	unit bgMedIncFm = 1;
run;

proc logistic data = work.analysis;
	*class Crit3l(ref = "No Photosensitivity" );
```

```
        model rd30l (event = "Hospitalized with readmission within 30 days") = bgMedIncFm ;*/selection = backward slstay =
0.05;
        *oddsratio  bgMedIncFm ;
run;

proc logistic data = work.analysis;
        class Crit3l(ref = "No Photosensitivity" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = bgMedIncFm acrcrit Crit3l/rsq lackfit;
        *oddsratio  bgMedIncFm ;
run;

proc logistic data = work.analysis;
        *class Crit3l(ref = "No Photosensitivity" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = bgMedIncFm acrcrit;*/selection = backward
slstay = 0.05;
run;

proc logistic data = work.analysis;
        class Crit3l(ref = "No Photosensitivity" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = Crit3l acrcrit;*/selection = backward slstay =
0.05;
run;

proc logistic data = work.analysis;
        class Crit3l(ref = "No Photosensitivity" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = bgMedIncFm Crit3l;*/selection = backward
slstay = 0.05;
run;


proc univariate data = work.analysis normal plot;
        var bgMedIncFm;
run;

proc means data = work.analysis n min max median qrange mean std;
        class rd30l;
        var bgMedIncFm;
run;

proc reg data=analysis;
    model rd30l=bgMedIncFm acrcrit Crit3l/ vif;
run;



proc logistic data = work.analysis;
        model rd30l (event = "Hospitalized with readmission within 30 days") = t_income ;
run;

proc logistic data = work.analysis;
        class Crit3l(ref = "No Photosensitivity" );
        model rd30l (event = "Hospitalized with readmission within 30 days") = t_income acrcrit Crit3l;*/selection = backward
slstay = 0.05;
        *unit bgMedIncFm = 1 acrcrit = 1;
run;


proc freq data = work.analysis;
        tables m_status*base_cat_label/cmh;
run;

proc freq data = work.analysis;
```

```
        tables insur_stat_label*rd30l/cmh;
run;


proc npar1way wilcoxon data = work.analysis;
        class hospital_label;
        var t_income;
run;

proc npar1way wilcoxon data = work.analysis;
        class base_cat_label;
        var t_income;
run;


proc npar1way wilcoxon data = work.analysis;
        class rd30l;
        var t_income;
run;


**********TIME TO READMISSION CODE;

data work.analysis;
        set x.final_thesis_data_surv;
        by trackid;
        marital_analysis= m_status;
        if m_status = "Unknown" then marital_analysis = "";
        length race_analysis $ 20;
        if race_l = "Black or African-American" then race_analysis = "Black";
                else race_analysis = "Non-Black";
        insurance_analysis = insur_stat_label;
                if insur_stat_label = 5 then insurance_analysis = .;
        t_income = bgMedIncFm/1000;
        if last.trackid;
        format insurance_analysis insur_.;
        label
                time_length = "Time to Readmission (in days)"
                icd_group_label= "Principal ICD 9 Group"
;
run;


ods graphics on;
ods select survivalplot(persist) failureplot(persist);

ods rtf file= "\\Client\H$\Desktop\Hazards Ratio Univariate Hospital Descriptive.rtf";


proc univariate data = analysis(where=(rd30=1));
var time_length;
histogram time_length / kernel;
run;

data work.aa;
        set work.analysis;
        where rd30 =1 ;
run;
proc lifetest data=work.aa plots=survival (cl atrisk);
  time time_length*rd30(0);
run;
```

```
proc means data = work.aa;
        var time_length;
run;

proc lifetest data=work.analysis plots=survival (cl test atrisk(maxlen=40));
  time time_length*rd30(0);
  strata icd_group_label/ test=logrank;
run;


proc means data = work.aa;
        class icd_group_label;
        var time_length;
run;

PROC phreg DATA= work.analysis;
        class gender(ref = "Male" );
        model time_length*rd30 (0) = gender/risklimits;
RUN;


PROC phreg DATA= work.analysis;
        class race_analysis(ref = "Non-Black" );
        model time_length*rd30 (0) = race_analysis/risklimits;
RUN;

PROC phreg DATA= work.analysis;
        class eth_label(ref = "Non- Hispanic" );
        model time_length*rd30 (0) = eth_label/risklimits;
RUN;

PROC phreg DATA= work.analysis;
        class marital_analysis(ref = "Single" );
        model time_length*rd30 (0) = marital_analysis/risklimits;
RUN;

PROC phreg DATA= work.analysis;
        class insurance_analysis(ref = "Insured" );
        model time_length*rd30 (0) = insurance_analysis/risklimits;
RUN;

PROC phreg DATA= work.analysis;
        class low3_label(ref = "Negative" );
        model time_length*rd30 (0) = low3_label/risklimits;
RUN;

PROC phreg DATA= work.analysis;
        class low4_label(ref = "Negative" );
        model time_length*rd30 (0) = low4_label/risklimits;
RUN;

PROC phreg DATA= work.analysis;
        class Crit1l(ref = "No Malar Rash" );
        model time_length*rd30 (0) = Crit1l/risklimits;
RUN;

PROC phreg DATA= work.analysis;
        class Crit2l(ref = "No Discoid Rash" );
        model time_length*rd30 (0) = Crit2l/risklimits;
RUN;

PROC phreg DATA= work.analysis;
```

```
        class Crit3l(ref = "No Photosensitivity" );
        model time_length*rd30 (0) = Crit3l/risklimits;
RUN;

PROC phreg DATA= work.analysis;
        class Crit4l(ref = "No Oral Ulcers" );
        model time_length*rd30 (0) = Crit4l/risklimits;
RUN;

PROC phreg DATA= work.analysis;
        class Crit5l(ref = "No Non-erosive Arthritis" );
        model time_length*rd30 (0) = Crit5l/risklimits;
RUN;

PROC phreg DATA= work.analysis;
        class Crit6l(ref = "No Pleuritis or  Pericarditis" );
        model time_length*rd30 (0) = Crit6l/risklimits;
RUN;


PROC phreg DATA= work.analysis;
        class Crit7l(ref = "No Renal Disorder" );
        model time_length*rd30 (0) = Crit7l/risklimits;
RUN;

PROC phreg DATA= work.analysis;
        class Crit8l(ref = "No Neurologic Disorder" );
        model time_length*rd30 (0) = Crit8l/risklimits;
RUN;

PROC phreg DATA= work.analysis;
        class Crit9l(ref = "No Hematologic Disorder" );
        model time_length*rd30 (0) = Crit9l/risklimits;
RUN;


PROC phreg DATA= work.analysis;
        class Crit10l(ref = "No Immunologic Disorder" );
        model time_length*rd30 (0) = Crit10l/risklimits;
RUN;

PROC phreg DATA= work.analysis;
        class Crit11l(ref = "No Positive Antinuclear Antibody" );
        model time_length*rd30 (0) = Crit11l/risklimits;
RUN;

******END OF CAT;



*begin numerical;
PROC phreg DATA= work.analysis;
        model time_length*rd30 (0) = baseage/risklimits;
        hazardratio baseage/units = 1;
RUN;

PROC phreg DATA= work.analysis;
        model time_length*rd30 (0) = t_income/risklimits;
        hazardratio t_income/units = 1;
RUN;

PROC phreg DATA= work.analysis;
```

```
        model time_length*rd30 (0) = propgradhs/risklimits;
        hazardratio propgradhs/units = 1;
RUN;

PROC phreg DATA= work.analysis;
        model time_length*rd30 (0) = acrcrit/risklimits;
        hazardratio acrcrit/units = 1;
RUN;

PROC phreg DATA= work.analysis;
        model time_length*rd30 (0) = first_age/risklimits;
        hazardratio first_age/units = 1;
RUN;

PROC phreg DATA= work.analysis;
        model time_length*rd30 (0) = visit/risklimits ;
        hazardratio visit / units = 1;
RUN;

ods rtf close;


ods rtf file = "\\Client\H$\Desktop\survival multivariate.rtf";
PROC phreg DATA= work.analysis;
        class gender(ref = "Male" ) race_analysis (ref = "Non-Black") insurance_analysis (ref = "Insured") Crit3l(ref = "No
Photosensitivity" ) Crit6l(ref = "No Pleuritis or  Pericarditis" ) Crit7l(ref = "No Renal Disorder" ) Crit8l(ref = "No Neurologic
Disorder" ) Crit9l(ref = "No Hematologic Disorder" ) ;
        model time_length*rd30 (0) =  t_income propgradhs gender race_analysis insurance_analysis crit3l crit6 crit7l crit8l
crit9l/risklimits selection = forward slentry = 0.05 ;
RUN;

PROC phreg DATA= work.analysis;
        class gender(ref = "Male" ) race_analysis (ref = "Non-Black") insurance_analysis (ref = "Insured") Crit3l(ref = "No
Photosensitivity" ) Crit6l(ref = "No Pleuritis or  Pericarditis" ) Crit7l(ref = "No Renal Disorder" ) Crit8l(ref = "No Neurologic
Disorder" ) Crit9l(ref = "No Hematologic Disorder" ) ;
        model time_length*rd30 (0) =  t_income propgradhs gender race_analysis insurance_analysis crit3l crit6 crit7l crit8l
crit9l/risklimits selection = backward slstay = 0.05 ;
RUN;

proc corr data = analysis plots(maxpoints=none)=matrix(histogram);
var time_length bgMedIncFm propgradhs gender race_analysis insurance_analysis crit3l crit6 crit7l crit8l crit9l; *include
important variables here;
run;
ods rtf close;
```