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Article

Racial Inequities Influencing Admission, Disposition and Hospital Outcomes for Sickle Cell Anemia Patients: Insights from the National Inpatient Sample Database

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Simple Summary: Our study highlights significant racial disparities in the hospital outcomes of sickle cell disease (SCD) patients, focusing on African-American and Hispanic populations. Using data from over a million hospitalizations between 2016 and 2020, our research found that African-American and Hispanic patients were more likely to be admitted non-electively, experience longer hospital stays, and face higher rates of complications like acute kidney injury and pain crises compared to White patients. Hispanics also had the highest in-hospital mortality. These findings underscore the need for targeted healthcare interventions to address these inequities and improve outcomes for all SCD patients.

Abstract: Background: Sickle cell disease (SCD) significantly impacts diverse racial groups, particularly African American and Hispanic persons, who experience notable disparities in healthcare outcomes. Despite the extensive literature on SCD, studies focusing on in-hospital racial inequities remain limited. Methods: We conducted a retrospective analysis using the National Inpatient Sample (NIS) from 2016 to 2020, identifying adult hospitalizations for SCD. Hospitalizations were categorized by race—White, African-American, Hispanic, and Other, and analyzed for demographic variables, admission types, disposition outcomes, and complications. Statistical analyses included chi-square tests and multivariate logistic regression, adjusting for confounders. Results: Of the 1,089,270 identified hospitalizations, 90.31% were African-American. African-American and Hispanic patients exhibited significantly higher non-elective admissions compared to Whites (77.81%). In-hospital mortality was highest among Hispanics (0.82%). Multivariate regression analysis revealed that African-Americans and Others had higher odds of prolonged hospital stays (Adjusted Odds Ratio (AOR): 1.30 and 1.20, respectively). African-Americans and Hispanics also had increased risks of in-hospital complications of SCD. Conclusion: This study highlights substantial racial disparities in SCD hospitalizations, with African Americans and Hispanics facing poorer outcomes compared to Whites. Hispanics also demonstrated increased mortality. These findings underscore the need for targeted healthcare interventions to address racial inequities in SCD management and improve outcomes for all affected populations.

Keywords: sickle cell; racial sickle cell; racial inequities; sickle cell anemia

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1. Introduction

Sickle cell disease (SCD) is an autosomal-recessive hemoglobinopathy which is caused by the replacement of negatively charged glutamine with the neutral valine at the 6th codon of the beta globin chain of Hemoglobin. [1] Historically, SCD is more prevalent in sub-Saharan Africa, however recent data shows that about 20 million people are affected by SCD worldwide and approximately 100,000 Americans have SCD. [2,3] Among African-American births in the United States, the frequency of SCD is 1 in 360 live births. [4] Centers for Disease Control and Prevention (CDC) estimates that 1 in 13 babies born to African-American parents have sickle cell trait, and 1 in 365 African-Americans have SCD. Numerous studies underscore the criticality of risk stratification and the inclusion of race in elucidating disease processes. When it comes to SCD, literature is scarce, and studies have mostly been conducted on targeted populations. Existing research focused on genetic and economic disparities among SCD patients, and studies specifically addressing in-hospital populations are rare. [5,6] Moreover, since most of the affected populations are of African-American origin, existing research and therapy is focused on this subgroup which may jeopardize the outcomes of other minority populations with SCD. In this study, we analyzed the impact of race on in-hospital outcomes of SCD patients with a focus on minority races. The study also analyzes the impact of race on admission and disposition outcomes which are known to cause a significant impact on healthcare burden and patient satisfaction. [7]

2. Methods

2.1. Database- The National Inpatient Sample 2016-2020

The National Inpatient Sample (NIS) stands as the United States' most extensive publicly accessible database for inpatient healthcare, encompassing data from various payers. It serves as a crucial tool for extensive data analysis, offering regional and national insights into inpatient usage, accessibility, costs, quality of care, insurance, demographic information and clinical outcomes. Created through a collaborative effort between federal, state, and industry partners under the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project (HCUP), it includes information from approximately 20% of hospital admissions every year. Our institution's (Trinity Health Oakland) Institutional Review Board approved the usage of NIS' deidentified data for this study.

2.2. Study Population and Study Variables

The NIS 2016-2020 was queried and International Classification of Disease- Tenth Edition-Clinical Modification (ICD-10-CM) codes were used to identify adult (age >18 years) hospitalizations with a primary or secondary diagnosis of SCD. This population was stratified by race into Whites, African-Americans, Hispanics and Others (Asian, Native-american, Pacific islander). Socio-demographic variables including age, sex, insurance, income quartiles and hospital characteristics including hospital size, location, region and teaching status were compared in different races. The main outcomes studied were type of admission (elective vs non-elective), type of disposition (home vs assisted living facility/home health-care vs died) and healthcare utilization (length of stay greater than or less than 7 days). Complications of sickle cell anemia hospitalizations like Acute kidney Injury (AKI), Pain crisis, Deep Vein Thrombosis (DVT), Acute chest syndrome, Cerebro-Vascular Accident (CVA) and Pulmonary Hypertension (PHTN) were also compared in different races.

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2.3. Statistical Analysis

A cross-sectional analysis was done using the STATA/MP 17.0 software. Categorical variables were compared using chi-square test and continuous variables were compared using t-test. P values < 0.05 were considered statistically significant. Multivariate logistic regression analysis was conducted to analyze the impact of race on type of admission, type of disposition, healthcare utilization and complications like AKI, pain crisis, DVT, acute chest syndrome, CVA and PHTN while accounting for pertinent confounders. These included socio-demographics, hospital characteristics, the Charlson comorbidity index [8], and other cardiac risk factors, including tobacco use, hypertension, hyperlipidemia, diabetes, cannabis use and obesity.

3. Results

3.1. Patient and Hospital Level Characteristics

A total of 1,089,270 SCD hospitalizations were identified with a mean age of 35.81 years. 65.29% of these patients were women. Majority of sickle cell anemia hospitalizations were African-American (90.31%), followed by Hispanics (4.08%), others (2.99%) and whites (2.08%).

Less than 20% of hospitalizations among African-Americans, Hispanics and others were older than 65 years. However, among whites, 36.22% were found to be greater than 65 years (p<0.001). Irrespective of race, the majority of SCD hospitalizations were women (p<0.001). In all race categories, the highest proportion of people had a median household income in the lowest income quartile, with 51.74 % African-Americans and 45.91% Hispanics in this category compared to 31.58% of Whites. Only 9.75% of African-Americans SCD patients had income in the highest income quartile compared to 20.54% of whites (p<0.001). Majority of white SCD patients had private insurance (33.14%) whereas most African-Americans (44.75%), Hispanics (53.21%) and others (45.74%) had Medicaid. (p<0.001) Among whites and African-Americans, the majority were hospitalized in the Southern region of the United States whereas Hispanics and Others were mostly hospitalized in the North-East (p<0.001). Irrespective of race, the majority were treated at urban-teaching hospitals. (p<0.001). [Table 1]

Table 1. Patient and hospital-level characteristics of hospitalized adult SCD patients stratified by race in the NIS (2016-2020).

Variables	White [22,710] (%)	African-American [981,759] (%)	Hispanic [52,176] (%)	Others [32,569] (%)	p-value
Age					
Less than 65 years	63.78	82.93	87.72	85.06	<0.001
Greater than 65 years	36.22	17.07	12.28	14.94	
Gender					
Male	33.02	35.15	29.18	30.85	<0.001
Female	66.98	64.85	70.82	69.15	
Median household income national quartiles					
Quartile 1 (0-25th percentile)	31.58	51.74	45.91	37.91	<0.001

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Quartile 2 (26-50th percentile)	24.37	22.41	23.45	20.84	
Quartile 3 (51-75th percentile)	23.51	16.10	18.70	20.79	
Quartile 4 (76-100th percentile)	20.54	9.75	11.94	20.46	
Insurance Type					
Medicare	31.24	29.11	17.30	16.98	<0.001
Medicaid	28.75	44.75	53.21	45.74	
Private	33.14	19.88	21.66	29.50	
Other	6.88	6.27	7.83	7.77	
Hospital Region					
Northeast	23.15	18.54	45.73	45.36	<0.001
Midwest	18.34	19.92	4.80	9.02	
South	42.63	53.39	38.34	36.05	
West	15.89	8.15	11.12	9.17	
Hospital Location					
Rural	3.80	3.67	1.13	2.33	<0.001
Urban non-teaching	19.93	14.04	12.33	11.49	
Urban teaching	76.27	82.29	86.55	85.17	
Hospital bed size					
Small	20.04	16.35	16.14	14.27	0.1864
Medium	25.37	26.75	27.49	26.84	
Large	54.58	56.89	56.37	58.89	

3.2. Primary Outcomes

In all races, most of the population had a routine discharge to home. Whites had a higher percentage of discharge to facility/home health care (21.09%) compared to African-Americans (11.24%), Hispanics (9.97%) and others (12.30%) ($p<0.001$). Hispanics with SCD had the highest in-hospital mortality (0.82%), followed by whites (0.80%), African-Americans (0.64%) and others (0.54%). ($p<0.001$). The highest proportion of hospitalizations from all races were admitted non-electively ($p<0.001$) and had a length of stay less than 1 week ($p<0.001$). [Table 2]

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Table 2. Racial differences in admission and disposition outcomes, and healthcare utilization among SCD patients in the NIS (2016–2020).

OutcomeS	White [22,710] (%)	African-American [981,759] (%)	Hispanic [52,176] (%)	Others [32,569] (%)	p-value
Patient disposition					
Routine	78.11	88.11	89.21	87.16	<0.001
Transfer to facility/home health care	21.09	11.24	9.97	12.30	
Died	0.80	0.64	0.82	0.54	
Admission Type					
Non- Elective	77.81	87.70	83.30	81.74	<0.001
Elective	22.19	12.30	16.70	18.26	
Length of stay					
Less than 7 days	80.13	78.09	81.16	78.80	<0.001
More than 7 days	19.87	21.91	18.84	21.20	

Multivariate logistic regression analysis, adjusted for confounders was performed after assigning whites as the reference group. It showed that compared to whites, all other race categories had statistically significant lower odds of getting admitted electively to hospitals. It was also found that, as opposed to whites, African-Americans and others had a statistically significant higher odds of a prolonged hospital stay greater than 7 days [Adjusted Odds Ratio (AOR): 1.30 (95% Confidence Interval (CI):1.17-1.42, p<0.001) in African-Americans and AOR: 1.20 (CI: 1.05-1.37, p=0.006) in others]. No statistically significant associations were found between the races in terms of disposition to home vs facility/home health care vs died. [Table 3].

Table 3. Multivariate regression analysis of racial differences in admission and disposition outcomes, and healthcare utilization of SCD patients in the NIS (2016–2020).

	Elective vs non-elective admission AOR* [95% CI, p-value]	Facility/home health vs routine AOR* [95% CI, p-value]	Died vs routine AOR* [95% CI, p-value]	Length of stay > 7 days AOR* [95% CI, p-value]
White [22,710]	Reference	Reference	Reference	Reference
African-American [981,759]	0.50 (0.45-0.56, <0.001)	0.88 (0.69-1.14, 0.352)	1.53 (0.61-3.85, 0.362)	1.30 (1.17-1.42, <0.001)
Hispanic [52,176]	0.75 (0.65-0.84, <0.001)	0.79 (0.57-1.09, 0.159)	2.29 (0.71-7.37, 0.165)	1.06 (0.94-1.20, 0.289)

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Other [32,569]	0.80 (0.69-0.93, 0.003)	0.86 (0.61-1.20, 0.387)	1.35 (0.37-4.95, 0.648)	1.20 (1.05-1.37, 0.006)

*Adjusted Odds Ratio (AOR) (for confounders: socio-demographics, hospital characteristics, the Charlson comorbidity index, and other cardiac risk factors, including tobacco abuse, hypertension, hyperlipidemia, diabetes, cannabis use and obesity).

3.3. In-Hospital Complications

Racial differences in the occurrence of the most common complications encountered in the in-patient population of SCD were analyzed using multivariate logistic regression analysis. It showed that compared to whites; African-Americans, Hispanics and others had statistically significant higher odds of developing AKI, pain crisis, acute chest syndrome and PHTN. On the contrary, odds of occurrence of cerebrovascular accidents were found to be lower in all other race categories compared to whites. A higher odds of DVT was found among African-Americans and others compared to whites, however the difference in odds of developing DVT was not statistically significant in Hispanics compared to whites. [Table 4].

Table 4. Multivariate regression analysis of racial differences in the occurrence of in-hospital complications of SCD patients in the NIS (2016–2020).

Complications	**White [22,710]**	**African-American [981,759] AOR* [95% CI, p-value]**	**Hispanic [52,176] AOR* [95% CI, p-value]**	**Others [32,569] AOR* [95% CI, p-value]**
AKI	Reference	1.68 (1.46-1.94, 0.001)	1.31 (1.09-1.57, 0.003)	1.51 (1.25-1.83, 0.001)
Pain Crisis	Reference	3.61 (3.22 - 4.05, 0.001)	1.93 (1.69-2.21, 0.001)	2.11 (1.80-2.48, 0.001)
DVT	Reference	1.43 (1.09-1.87, 0.011)	1.01 (0.73-1.39, 0.949)	1.44 (1.01-2.03, 0.041)
Acute Chest Syndrome	Reference	1.80 (1.41-2.30, 0.001)	1.60 (1.22-2.11, 0.001)	1.56 (1.17-2.08, 0.002)
CVA	Reference	0.36 (0.29-0.44, 0.001)	0.40 (0.28-0.57, 0.001)	0.42 (0.28-0.64, 0.001)
PHTN	Reference	1.98 (1.61-2.44, 0.001)	1.69 (1.29-2.22, 0.001)	1.18 (0.89-1.56, 0.241)

*Adjusted Odds Ratio (AOR) (for confounders: socio-demographics, hospital characteristics, the Charlson comorbidity index, and other cardiac risk factors, including tobacco abuse, hypertension, hyperlipidemia, diabetes, cannabis use and obesity).

4. Discussion

The findings of this study illuminate critical racial disparities affecting SCD patients in the United States during hospital admissions from 2016 to 2020. The distribution and characterization of sickle cell anemia hospitalizations varied remarkably among races. In addition to having the highest proportion-burden of SCD hospitalizations, African-Americans were also found to have significantly poor in-hospital outcomes and mortality compared to whites. Previous studies had smaller sample sizes with more focus on comparison of African Americans with Whites. [9] Our study also focussed

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on Hispanics, the race category with second highest prevalence of SCD in the United States, along with admission and disposition outcomes and in-hospital complications. Hispanics were also found to have notably worse in-hospital outcomes compared to whites. This raises important questions about the systemic factors contributing to these inequities.

The analysis of the data reveals a significant disparity in the age distribution of individuals with SCD among different racial groups. Specifically, White patients exhibited a higher proportion of patients >65 years of age compared to African-American, Hispanic, and other racial categories, while the median life expectancy of SCD patients is 42 years for females and 38 years for males. [10] This higher life expectancy in White SCD patients may be due to a higher proportion of Whites in the highest income quartiles and a similar higher prevalence of private insurance among White individuals. This is supported by observations from previous research that have highlighted that SCD patients reliant on Medicare and Medicaid tend to experience lower life expectancies. [11] Additionally, it has been documented that Medicare and Medicaid beneficiaries often face limitations in their choices of nursing homes, with many options being of lower quality, leading to a higher likelihood of rejection compared to the options available to those with private insurance. [12] This may contribute to the observed pattern of higher rates of discharge to nursing homes for White patients. In contrast, other racial groups are more frequently discharged to home settings.

Compared to Whites, African-Americans and Hispanics had higher odds of getting admitted non-electively which contributes to higher healthcare utilization compared to elective admissions. A previous study has reported a declining trend of non-elective admissions in Whites and an increasing trend of the same in African-Americans. [13] The observed higher length of stay in African-Americans can be attributed to a complex interaction between patient and health-care related factors like medication adherence, failure of physicians to timely recognize impending complications, difficulty with discharge planning and suboptimal pain management. [14] The increased length of stay in African-American patients could be supported by studies showing increased average wait times in emergency rooms for African-American SCD patients leading to delay in care delivery. [14] A recent study also showed that patients who perceived discrimination in their care reported higher pain burden, which could delay discharge due to inability to achieve goal pain score. [15]

African-Americans, Hispanics and others had higher odds of AKI, pain crisis and acute chest syndrome compared to Whites. This could be due to the higher association of alpha thalassemia in white SCD patients, which is a protective factor against many SCD related complications. [16] However, higher odds of developing PHTN is found only in African-American and Hispanic SCD patients. This is consistent with studies showing higher prevalence of PHTN in Hispanics and lower incidence in Asian Americans owing to a lower left ventricular mass. [17] Compared to Whites, all other racial groups had a lower odds of developing cerebrovascular accidents. This correlated with a higher prevalence of sickle cell thalassemia in Whites, which lead to higher transfusions, increasing viscosity and inflammation, contributing to large vessel occlusion. [18]

As we analyze these results, it is vital to consider the broader implications for healthcare delivery and policy aimed at improving the quality of care for marginalized racial groups. Understanding such health outcome variations among racial groups is crucial for developing tailored diagnostic and management protocols, ensuring equitable treatment efficacy.

5. Conclusion

In conclusion, this study reveals significant racial disparities in hospitalization outcomes for SCD patients, particularly highlighting the challenges faced by African-American and Hispanic populations. The findings demonstrate that these groups experience higher rates of non-elective admissions, prolonged hospital stays, and increased complications, underscoring the need for targeted healthcare interventions. Addressing these inequities is crucial for improving patient outcomes and ensuring equitable care for all individuals affected by SCD.

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6. Limitations

NIS lacks detailed patient-level data such as medications and laboratory results which could interfere with the studied outcomes. Thus, it was not feasible to eliminate these as potential confounders for the outcomes studied. Since the NIS database only includes data from hospitalized patients in the United States, it may not fully represent the entire world population of SCD, which is more prevalent in Sub-Saharan Africa. As a result, applying our findings to a larger population could pose challenges. The cross-sectional nature of our study limits its ability to assess the frequency and impact of readmissions on the studied outcomes. However, despite these shortcomings, the compelling disparities encountered in our study provoke important inquiries into the impact on race on outcomes of SCD hospitalizations.

7. Patents

There are no patents resulting from the work reported in this manuscript.

Author Contributions: Conceptualization, J.J.; methodology, J.J.; N.V.; writing—original draft preparation, J.J.; N.V.; M.G.; F.K.; M.A.; D.T.; K.B.; S.R.; C.B.; T.M.; writing—review and editing, J.J.; P.R.; supervision, P.R.;. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

SCD	Sickle cell disease
NIS	National Inpatient Sample
AOR	Adjusted Odds Ratio
CDC	Centers for Disease Control and Prevention
HCUP	Healthcare Cost and Utilization Project
ICD-10	International Classification of Disease- Tenth Edition- Clinical Modification
AKI	Acute Kidney Injury
DVT	Deep Vein Thrombosis
PHTN	Pulmonary Hypertension
CI	Confidence Interval

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