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Race and socioeconomic disparities persist in treatment and outcomes of patients with cervical spinal cord injuries: An analysis of the national inpatient sample from 2016 - 2020

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A B S T R A C T

Objective: Previous literature has described race and socioeconomic disparities in both treatment and outcomes following cervical spinal cord injuries (SCI). The goal of this study is to investigate the current state of parity in management and outcomes following SCI.
Methods: We surveyed the National Inpatient Sample database (NIS) for patients admitted with primary diagnosis of cervical SCI. 49,320 patients were identified. Univariate and multivariate analyses were performed to evaluate racial and socioeconomic differences in SCI care and outcomes.
Results: Compared to white patients, minority race was associated with a longer time from presentation to operative intervention ($p < 0.001$) and longer length of stay following admission for cervical SCI (16 vs 13 days, $p < 0.001$). Minority patients were more likely to have an unfavorable discharge (skilled nursing facility, against medical advice, death) status than white patients ($p < 0.001$). Patients in the bottom quartile of median household income were associated with more unfavorable discharges than the top two quartiles ($p < 0.001$). Patients with the lowest median household income quartile also had higher total costs than those in the top quartiles ($221,654 vs 191,723, $p < 0.001$). Black, Hispanic, and Asian/Pacific Islander incurred higher treatment costs than White patients.
Conclusion: Minority and lower socioeconomic status are independently associated with unfavorable discharge and LOS in cervical SCI. Furthermore, racial and economically disadvantaged groups have longer wait times from admission to surgical intervention. These disparities persist despite being highlighted by previous publications and increased societal awareness of healthcare inequities, necessitating further work to reach parity.

1. Introduction

Inequities in healthcare treatment persist today despite several decades of publications exposing disparities in healthcare and pledges from American Medical Association (AMA) and American Council of Graduate Medical Education (ACGME) to reduce these inequalities.[1] Race and socioeconomic status (SES) continue to influence patient outcomes and treatment paradigms in healthcare.[2] These inequalities persist across a broad range of conditions, treatments, and disciplines.[3–6]

A review of the National Inpatient Sample (NIS) database from 1998 to 2009 of socioeconomic and racial disparities in patients with cervical spinal cord injury (CSCI) with fracture (TCSCIF) by Dru et al found that Black, Hispanic, and lower socioeconomic patients were less likely to undergo surgery, despite improved outcomes in discharge disposition and mortality associated with surgical intervention.[3] Furthermore, the Surgical Timing in Acute Spinal Cord Injury Study (STASCIS) demonstrated improved neurologic outcome, defined as at least a 2 grade American Spinal Cord Injury Association (ASIA) Impairment Scale score (AIS) improvement when surgical decompression was performed within 24 h from time of cervical spinal cord injury.[7] Other reviews show improved morbidity, decreased length of stay (LOS), and lower associated healthcare costs with early surgical intervention.[8]

However, it is unclear if any meaningful reduction in healthcare disparities have occurred since 2009. This study aims to revisit the investigation of the NIS performed by Dru et al to explore any advances on racial or socioeconomic disparities in treatment and outcomes of CSCI. Differences in this study are the use of International Classification of Disease, 10th revision (ICD-10), study period of 2016–2020, and inclusion of all CSCI diagnoses. Furthermore, we include an analysis of time from presentation to surgical intervention, LOS, and total associated costs of treatment which supplement the Dru et al publication.

2. Methods

A retrospective cohort study was performed using the National Inpatient Sample (NIS). The NIS is a nationally representative database

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compiling data from hospitals participating in the Healthcare Cost and Utilization Project (HCUP). The NIS is comprised of de-identified inpatient hospitalization information derived from billing and discharge information. Utilization of discharge weights reported by participating institutions, allows for estimates of national statistics. The NIS approximates a 20 % sample of all hospital discharges in the United States drawn from data at all HCUP participating hospitals representing 97 % of the United States. No prior approval was sought from the Institutional Review Board at our facility due to the de-identification of the data and retrospective nature of the study.

A query of inpatient admissions with the primary diagnosis of CSCI from 2016 to 2020 was performed. Primary diagnosis ICD-10 code for CSCI was utilized to focus the search for patients admitted following CSCI. Patients who were diagnosed with ICD-10 codes S140XXA – S14103A were included in the study.

An initial analysis was preformed to trend the impact that intervention type (operative or non-operative) has on disposition following CSCI. For the first analysis, patient discharge was dichotomized into favorable and unfavorable discharge. The former denotes patients discharged routine, home with in–home healthcare or to a short-term rehabilitation facility, while the latter represents discharge to a long-term care facility, skilled nursing facility (SNF), leaving against medical advice, or discharged as deceased. Patients whose discharge location was unknown were not included in this analysis. The second analysis used mortality as the outcome variable, comparing deceased vs surviving status of patients. This analysis was performed with a binary logistic regression with included covariates of age, sex, hospital region, hospital size, teaching status, primary expected payer (Medicare, Medicaid, private insurance, self-pay, other, and no charge), number of ICD-10 diagnoses, number of ICD-10 procedures and year of admission.

Next, we performed an analysis to characterize the effects of SES and minority race on surgical intervention, mortality, and discharge disposition. The races included in the cohort were White, Black, Hispanic, Asian/Pacific Islander, Native American, and Other. The White patient group was compared to all the other listed races. SES was dichotomized into two groups representing the top three quartiles as highest SES (HSES) and the lowest socioeconomic status (LSES) quartile of median household income. The latter quartile according to data from the United States Census Bureau from 2016 to 2020 would fall below the poverty line at any given household size. Income quartile is a provided categorical variable from the NIS, providing an estimate of the median household income for residents in the patient's zip code. The same covariates from the initial analysis were applied here.

An additional analysis was completed to examine the intersection between race and SES on surgical intervention, disposition, and mortality following CSCI. To test this, 4 groups were created: White/HSES, minority/HSES, minority/LSES and White/LSES. We compared the odds of receiving operative intervention, favorable discharge, and mortality using binary logistic regression as was done with the first regression analysis. Furthermore, time from admission to surgical intervention, LOS, and total associated hospital costs were compared using an analysis of covariance (ANCOVA). Covariates included in the ANCOVAs were age, sex, hospital region, insurance type, hospital size, teaching status, admission year, number of ICD-10 procedures performed, and number of ICD-10 diagnoses. In addition to the aforementioned covariates, analysis of associated hospital costs included LOS as a covariate.

The last test performed was an ANCOVA comparing the time from admission to surgical intervention, LOS, and associated hospitals costs between race and SES. All analysis was done using Statistical Package for the Social Sciences (SPSS) Version 29.0 (IBM Corp., Armonk, N.Y., USA). Tests for significance were two-sided with a p-value less than 0.05 considered statistically significant.

3. Results

A total of 49,320 patients with CSCI were included in the study. Patient descriptive characteristics are listed in Table 1. The odds of having favorable discharge were 4 times higher for patients with CSCI who underwent operative management compared to patients who had non-operative management (OR 4.2, 95 % CI 4.0–4.0, $p < 0.001$). Patients receiving operative management were less likely to die during hospitalization than patients who had non-operative management (OR 0.70, 95 % CI 0.64–0.75, $p < 0.001$).

Minority race was a predictor of lower likelihood of receiving operative management following CSCI (OR 0.85, 95 % CI 0.82–0.89, p < 00.001). Black, Hispanic, Asian/Pacific Islander, and Other racial groups were less likely to receive operative intervention than White patients. Similarly, patients in the LSES had lower likelihood of receiving operative intervention following CSCI than patients from HSES backgrounds (OR 0.90, 95 % CI 0.86–0.95, $p < 0.001$).

In general minority patients with CSCI were less likely to have a favorable discharge disposition than White patients (OR 0.89 95 % CI 0.85–0.93, p < 00.001). Black patients were less likely than White patients to have a favorable discharge (OR 0.86, 95 % CI 0.81–0.91, p < 00.001). Minority patients had a lower odd of death than White patients (OR 0.63 95 % CI 0.57–0.70, $p < 0.001$). No difference was noted in the likelihood of favorable discharges between HSES patients and LSES (OR 1.08, 95 % CI 1.03–1.14, $p < 0.003$). Conversely, LSES was associated with lower liklihood of in hospital death (OR 0.88, 95 % CI 0.80–0.97, $p = 0.008$). Table 2 summarizes the observed disparities in treatment, discharge disposition and mortality.

Minority HSES patients were less likely to have operative intervention than White HSES patients (OR 0.81, 95 % CI 0.77–08.86, p < 0.001). While minority HSES patients were less likely than White HSES patients to have favorable discharge (OR 0.94, 95 % CI 0.89–0.99, p < 0.014), this was not true when compared to White LSES patients ($p = 0.897$). Minority patients from LSES backgrounds had a lower odd of favorable discharge than White HSES (OR 0.73, 95 % CI 0.66–0.8, p < 0.001) and White LSES (OR 0.78, 95 % CI 0.69–0.87, $p < 0.001$).

When characterizing ratios of favorable discharge and treatment stratifying by race and insurance payor status we found that of private payers, White individuals had higher rates of favorable discharge compared to the minority cohort. Further characterization of ratio of favorable discharge and treatment stratified by race and insurance payor

Table 1
Summary of all included patient demographics.

	Total	(%)
Age, mean (years)	58.2 ± 18.7	
Sex		
Male	36655	74.3
Female	12660	25.7
Unknown	5	–
Race/Ethnicity		
White	30335	61.5
Black	10155	20.6
Hispanic	3470	7
Asian/Pacific Islander	1485	3
Native American	400	0.8
Other	1515	3.1
Unknown	1960	4
Socioeconomic Status		
[a]HSES	38635	78.3
[a]LSES	9620	19.5
Unknown	1065	2.2
Payor Status		
Medicare	19600	39.7
Medicaid	8790	17.8
Private	14855	30.1
Self-Pay	2655	5.4
No Charge	150	0.3
Other	3135	6.4
Unknown	135	0.3

[a] Note: HSES: High Socioeconomic Status (top 3 quartiles by household income; LSES (Low Socioeconomic Status (bottom quartile by household income).

Table 2
Summary of disparities in treatment, unfavorable discharge status, and inpatient mortality.

	Treatment		Mortality		Favorable Discharge	
	OR (95 % CI)	*p*	OR (95 % CI)	*p*	OR (95 % CI)	*p*
White	Reference		Reference		Reference	
Minority	0.854 (0.82–0.89)	**<0.001**	0.63 (0.57–0.70)	**<0.001**	0.89 (0.85–0.93)	**<0.001**
White	Reference		Reference		Reference	
Black	0.84 (0.80–0.89)	**<0.001**	0.63 (0.56–0.71)	**<0.001**	0.86 (0.81–0.91)	**<0.001**
Hispanic	0.90 (0.83–0.98)	**.011**	0.64 (0.52–0.77)	**<0.001**	0.97 (0.88–1.05)	0.411
Asian/Pacific Islander	0.78 (0.69–0.87)	**<0.001**	0.50 (0.37–0.67)	**<0.001**	0.93 (0.82–1.05)	0.22
Native American	1.06 (0.85–1.32)	0.638	1.19 (0.79–1.81)	0.422	1.05 (0.83–1.32)	0.678
Other	0.70 (0.62–0.79)	**<0.001**	0.78 (0.61–0.99)	**.045**	1.17 (1.03–1.32)	**.013**
HSES	Reference		Reference		Reference	
LSES	0.90 (0.86–0.95)	**<0.001**	0.88 (0.80–0.97)	**.008**	1.08 (1.03–1.14)	**.003**
White HSES	Reference		Reference		Reference	
Minority HSES	0.81 (0.77–0.86)	**<0.001**	0.63 (0.56–0.71)	**<0.001**	0.94 (0.89–0.99)	**.014**
Minority LSES	0.97 (0.83–1.13)	0.658	0.43 (0.27–0.68)	**<0.001**	0.73 (0.66–0.81)	**<0.001**
White LSES	0.85 (0.80–0.90)	**<0.001**	0.76 (0.68–0.84)	**<0.001**	0.94 (0.88–1.01)	0.079
White LSES	Reference		Reference		Reference	
White HSES	1.18 (1.12–1.25)	**<0.001**	1.32 (1.19–1.47)	**<0.001**	1.06 (0.99–1.13)	0.079
Minority HSES	0.96 (0.90–1.03)	0.251	0.83 (0.72–0.96)	**.013**	1.00 (0.93–1.07)	0.897
Minority LSES	1.14 (0.97–1.34)	0.117	0.57 (0.36–0.90)	**.017**	0.78 (0.69–0.87)	**<0.001**

*Note: HSES: High Socioeconomic Status (top 3 quartiles by household income; LSES (Low Socioeconomic Status (bottom quartile by household income); All p-values defined as significant.

status is provided in Supplemental Table 1.

Compared to White patients with CSCI, minority patients had a longer interval between admission and surgical intervention (3 vs. 2 days, $p < 00.001$) and a longer LOS (16 vs. 13 days, $p < 00.001$). Black patients went a day longer between admission and operative intervention compared to White patients ($p < 00.001$). Black and Hispanic patients had a LOS of 17 and 15 days respectively compared to 13 from White patients with CSCI ($p < 00.001$). No difference was noted between race in general and total associated costs ($p = 0.764$). However, Black, Hispanic, Asian/Pacific Islander, and other patients all had higher costs of treatment than White patients (Table 3). LSES was not associated with a difference in time from admission to surgical intervention ($p = 0.222$), however LSES patients had a higher associated costs of treatment than those from higher median household income ($221,654 vs. $191,723, $p < 0.001$) despite shorter length of stay (15 vs. 12 days, $p < 0.001$).

Minority HSES patients had a longer time from admission to surgery than White patients from both HSES and LSES, (3 vs. 2 days, $p < 0.001$), for both. The same findings were noted for minority LSES patients compared to White HSES and LSES patients (4 vs. 2 days, $p < 0.001$). Minority patients from higher income had a longer LOS compared to White patients from higher income (18 vs. 14 days, $p < 0.001$) and those from LSES (18 vs. 12 days, $p < 00.001$). A similar finding was seen for minority LSES compared to White HSES (17 vs. 13 days, $p < 0.004$) and White LSES patients (17 vs. 12 days, $p < 00.001$). There was no difference in total associated costs between minority LSES patients and White patients from higher income status ($p = 0.27$). Conversely, minority HSES patients had higher treatment costs than White HSES patients from ($211,542 vs. $185,202 $p < 0.001$). The differences in time from admission to treatment, length of stay, and total costs are summarized in Table 3.

4. Discussion

While Dru et al found that over the period from 1998 to 2009 there was a positive trend in operative intervention for minority and lower socioeconomic groups with operative interventions and favorable discharge, parity with White patients does not appear to be met. We found that in CSCIs, minority patients are still less likely than White

Table 3
Summary of disparities in time to treatment, length of stay, and total costs.

	Time from Admission to Treatment (days unless noted)	*p*	Length of Stay (days)	*p*	Total Costs ($)	*p*
White	2	**<0.001**	13	**<0.001**	179,523	0.764
Minority	3		16		225,899	
White (Reference)	35 h		11		179,523	
Black	39 h	**.002**	14	**<0.001**	214,005	**<0.001**
Hispanic	43 h	**<0.001**	13	**<0.001**	258,296	**<0.001**
Asian/Pacific Islander	44 h	**<0.001**	13	**<0.001**	241,468	**<0.001**
Native American	30 h	1.000	13	0.072	188,570	**.004**
Other	48 h	**<0.001**	14	**<0.001**	293,049	**<0.001**
HSES	3	0.222	15	**<0.001**	191,723	**<0.001**
LSES	2		12		221,654	
White HSES (Reference)	2		14		185,202	
Minority HSES	3	**<0.001**	18	**<0.001**	211,542	**<0.001**
Minority LSES	4	**<0.001**	17	**.004**	200,600	0.273
White LSES	2	0.612	12	**<0.001**	202,040	**<0.001**
White LSES (Reference)	2		12		202,040	
Minority HSES	3	0.612	18	**<0.001**	211,542	**<0.001**
Minority LSES	4	**<0.001**	17	**<0.001**	200,600	**<0.001**
White HSES	2	**<0.001**	14	**<0.001**	185,202	**<0.001**

*Note: HSES: High Socioeconomic Status (top 3 quartiles by household income; LSES (Low Socioeconomic Status (bottom quartile by household income); All p-values defined as significant are found in bold in the above table when <0.05.

patients to have operative intervention — with Black patients having lower odds of receiving operative intervention. Similarly, patients from LSES backgrounds have lower odds of being treated surgically than more wealthy individuals. Our study adds to the findings in the Dru publication by demonstrating that disparities are present in time from presentation to operative intervention for minority, Black, and LSES patients.

Consequently, these disparities in treatment contributed to persistently higher likelihood of unfavorable discharge noted in minority and Black patients. As was seen in Dru et al, operative intervention continues to lead to a higher likelihood of favorable discharge. Conversely, LSES did not appear to be more likely to suffer unfavorable discharge despite receiving less operative intervention. Although, LSES did not have prolonged intervals between presentation and operative intervention which confers an outcomes advantage in CSCI.[7,8] Additionally, our study found race and income-based disparities in associated costs of treatment. Race and SES have been found to play a role in access to cheaper treatment alternatives such as having surgeries done at an ambulatory surgery center versus a hospital setting.[9] Interestingly, in our cohort, minority and LSES were found to have decreased of inpatient mortality. This is a seemingly paradoxical finding that may be explained by variables we did not assess. Previous literature has described higher rates of lifesaving interventions used in minority and LSES patients suffering from detrimental neurological pathology.[10] While minority patients and LSES were less likely to receive surgical treatment for their spinal cord injury, it remains possible that additional interventions to prolong life in patients with poor prognosis was pursued. We postulate that this would contribute to lower inpatient mortality while increasing the patient's chance of unfavorable discharge. Prognostically, these patients may not be likely to survive long term but would not be represented as an inpatient mortality in the National Inpatient Sample.

Individually, racial disparities are so profound that they transcend class. Various publications have demonstrated a unique intersection between SES and race, where minority patients from higher SES and class experience worse outcomes than White patients from poorer backgrounds.[11,12] College educated Black women are three times more likely than White women without a college degree to experience severe maternal complications.[11] Our study demonstrated that minority patients were more likely to have a delay in intervention and longer LOS regardless of SES. Understanding the interplay between race and class is critical to improving the long-term health of racial minorities. Low SES in addition to minority status portends the worst outcomes. The Weathering hypothesis describes the interconnected nature of various systems of oppression and explains the layered effects this can have on healthcare.[13] For instance, this hypothesis has been used to illustrate that compared to White women, Black woman experience accelerated rates of aging and worse healthcare outcomes as a result of the cumulative impact of social and racial stressors.

Race and socioeconomic inequality in healthcare is multifactorial, with trust, education, and representation all playing a role. For instance, Black communities have a strong distrust of the healthcare system with events such as the Tuskegee experiment having lingering effects.[14] This has had a negative influence on patients from Black communities seeking healthcare. Further compounding issues with trust is a paucity of education and lack of representation from marginalized communities in healthcare. A study of internal medicine resident education found that less than half of residency programs have lessons on healthcare disparities as part of the curriculum.[15] Minority representation in healthcare is also poor. Out of the 20 largest medical specialties none have achieved levels of Black and Hispanic physician representation to match the proportion of either group in the general population. At the current rate it would take 77 years for the closest specialty to do so for Black patients.[16] Healthcare also lacks socioeconomic representation with one study finding that across all races and ethnic groups medical school matriculants came from mostly wealthier households.[17]

While progress is being made on improving race and socioeconomic disparities the current pace is lethargic. Medical school and residency curriculums should include lessons on healthcare disparities so that future and practicing physicians know to be aware of inequities when making treatment decisions. This is not to say that total responsibility for improving disparities rests solely on the treating physician. The current United States healthcare system is not well constructed to take care of a growing heterogenous population. Factors such as social determinants of health and insurance payor status also play significant roles in treatment and outcomes. Prior studies have demonstrated that racial and ethnic minorities are disproportionately represented among the uninsured.[18] Individuals requiring expensive surgical intervention who are not insured may represent a group vulnerable to not receiving timely care or care at all due simply due to financial limitations. To combat disparity in health care outcomes, the Department of Health and Human Service has committed to transforming the healthcare system to serve and increasingly diverse patient group. These strategies mirror recommendations from a landmark article on racial disparity in healthcare from the Institute of Medicine. This study identified the need for continued characterization of sources of disparity, increase the number of underrepresented minority workers in the healthcare workforce, and integrate cultural education into healthcare training.[19] Physicians from the neurosurgical discipline should carefully consider confounding factors of a patient's background when proposing treatment regimens to patients.

5. Limitations

This study is primarily limited by its retrospective design and the inherent nature of sampling from a large national database like the NIS. The data contained within the NIS is strictly from participating hospitals in the United States and estimates only approximately 20 % of all discharges in the US. This limits interpretation of results as they may not be generalizable to other populations. We are also limited by the lack of granular data that is not available in the NIS. This includes presenting neurologic status, individual exam findings, imaging, and other details of the patient hospital course, all of which are of value in assessment of spinal cord injury. Initial severity of spinal cord injury is likely a strong determinant on both short- and long-term outcomes of patients. Inability to characterize the presenting injury severity remains a significant limitation in providing true measures of outcomes in our cohort. Long term functional outcome data at the patient level is also unknown as the NIS only provides a snapshot of inpatient stays as well as disposition status. Furthermore, the racial experience of minority groups is not homogenous. Even within racial or ethnic groups there is colorism which can stratify individual experiences. Our model examining the intersection between race and SES is limited by this, given that some racial minority groups have higher median household incomes on average than their White counterparts. Lastly, not all minorities are underrepresented in medicine (URiM), a study focusing on URiM groups may yield different results.

6. Conclusion

Race and socioeconomic disparities in management and outcomes following CSCIs persist despite published studies highlighting them. Black patients and those from low socioeconomic households are less likely to receive timely surgical intervention compared to White and more wealthy patients. This has a negative impact on outcomes such as LOS and discharge location. More work needs to be done to improve race and income representation in medicine to help address some of the causes of noted disparities. Moreover, continued investigation of areas where disparities may exist or areas in which progress may not be occurring is necessary to track and lead effect progress.

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Jean-Luc K. Kabangu: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Cody A. Heskett:** Writing – review & editing, Writing – original draft, Investigation, Data curation. **Frank A. De Stefano:** Writing – review & editing, Investigation, Data curation. **Ahmad Masri-Elyafaoui:** Writing – review & editing, Investigation. **Lane Fry:** Formal analysis, Investigation, Methodology, Writing – review & editing. **Ifije E. Ohiorhenuan:** Writing – review & editing, Supervision, Project administration.

Declaration of competing interest

All authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.wnsx.2024.100384.

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Abbreviations

ACGME: American Council of Graduate Medical Education
AMA: American Medical Association
ASIA: American Spinal Cord Injury Association
AIS: ASIA impairment scale
CSCI: Cervical spinal cord injury
LOS: Length of stay
LSEQ: Lowest socioeconomic quartile
NIS: National Inpatient Sample
SES: Socioeconomic status
SNF: Skilled nursing facility
STASCIS: Surgical Timing in Acute Spinal Cord Injury Study
URiM: Underrepresented in medicine