Original Article

Influence of psychosocial and sociodemographic factors in the surgical management of traumatic cervicothoracic spinal cord injury at level I and II trauma centers in the United States

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Background: Socioeconomic factors can bias clinician decision-making in many areas of medicine. Psychosocial characteristics such as diagnosis of alcoholism, substance abuse, and major psychiatric disorder are emerging as potential sources of conscious and unconscious bias. We hypothesized that these psychosocial factors, in addition to socioeconomic factors, may impact the decision to operate on patients with a traumatic cervicothoracic fracture and associated spinal cord injury (SCI).

Methods: We performed a cohort analysis using clinical data from 2012–2016 in the American College of Surgeons (ACS) National Trauma Data Bank at academic level I and II trauma centers. Patients were eligible if they had a diagnosis of cervicothoracic fracture with SCI. Using ICD codes, we evaluated baseline characteristics including race; insurance status; diagnosis of alcoholism, substance abuse, or major psychiatric disorder; admission drug screen and blood alcohol level; injury characteristics and severity; and hospital characteristics including geographic region, non-profit status, university affiliation, and trauma level. Factors significantly associated with surgical intervention in univariate analysis were eligible for inclusion in multivariate logistic regression.

Results: We identified 6,655 eligible patients, of whom 62% underwent surgical treatment (n=4,137). Patients treated non-operatively were more likely to be older; be female; be Black or Hispanic; have Medicare, Medicaid, or no insurance; have been assaulted; have been injured by a firearm; have thoracic fracture; have less severe injuries; have severe TBI; be treated at non-profit hospitals; and be in the Northeast or Western U.S. (all $P<0.01$). After adjusting for confounders in multivariate analysis, only insurance status remained associated with operative treatment. Medicaid patients (OR=0.81; P=0.021) and uninsured patients (OR=0.63; $P<0.001$) had lower odds of surgery relative to patients with private insurance. Injury severity and facility characteristics also remained significantly associated with surgical management following multivariate regression.

Conclusions: Psychosocial characteristics such as diagnosis of alcoholism, substance abuse, or psychiatric illness do not appear to bias the decision to operate after traumatic cervicothoracic fracture with SCI. Baseline sociodemographic imbalances were explained largely by insurance status, injury, and facility characteristics in multivariate analysis.

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Keywords: Trauma; spinal cord injury (SCI); socioeconomic status; insurance; race

Submitted May 22, 2021. Accepted for publication Jul 30, 2021.
doi: 10.21037/jss-21-37
View this article at: https://dx.doi.org/10.21037/jss-21-37

Introduction

It is estimated that 15 to 40 million spinal cord injuries (SCIs) occur each year throughout the world, predominantly from motor vehicle accidents, work-place related injuries or other traumatic etiologies (1). SCI often results in significant disability, with increased mortality and decreased quality of life (2,3). Long term complications include chronic pain, osteoporosis, autonomic dysreflexia, depression, and anxiety (3,4). Furthermore, patients with SCI are at increased risk for unemployment and suicide following their injury (5,6).

Social determinants of health including gender, race, insurance, and socioeconomic status, as well as psychosocial factors related to mental health, are a growing focus of healthcare outcomes research (7). In spine surgery, previous studies have investigated how sociodemographic factors influence elective orthopedic surgery rates and complications (8). Multiple studies have found that patients who identify as part of ethnic and racial minorities are less likely to undergo elective orthopedic procedures (9-17). Sociodemographic variables, like race, influence both patient outcomes and physician treatment decisions (18,19). Furthermore, patients in vulnerable social groups are at a higher risk of receiving insufficient shared decision-making and informed consent in the preoperative period (20). Existing literature focuses predominantly on disparities with respect to these factors in elective spine surgery outcome and does not account for many social determinants such as insurance type, and psychosocial factors such as alcoholism, substance abuse, or major psychiatric disorders. It is still largely unknown whether or how these factors bias the decision to proceed with emergency surgery. Identification of whether specific sociodemographic and psychosocial factors affect the decision to pursue spine surgery may improve shared decision-making and healthcare equality—for instance, recognizing such sources of bias may make way for more actionable changes than simply recognizing the net effect of such bias in the form of disparate outcomes, as many past studies have done.

Treatment for spine trauma with SCI provides an opportunity to assess bias in care patterns based on social determinants in a scenario where management would perhaps be expected to be most independent of these factors. It has been postulated that disparities in healthcare utilization are not as prominent for emergent care as compared to outpatient medical treatment because of the emergent nature of the provider's decisions (21,22). However, data addressing this question are lacking in the field of spine surgery. Understanding if, and how, socioeconomic, and psychosocial factors affect surgical management of traumatic cervicothoracic fracture with SCI is a step toward better understanding barriers to healthcare utilization. Identifying sources of bias may ultimately help to ameliorate disparities in care.

The objectives of this study are to further elucidate the relationship between sociodemographic and psychosocial factors and the decision to operate at academic trauma centers in the US following cervicothoracic trauma with SCI. Emergency surgery is resource intensive (23), and we hypothesized that differences in treatment exist based on sociodemographic and psychosocial patient characteristics.

We present the following article in accordance with the STROBE reporting checklist (available at https://dx.doi.org/10.21037/jss-21-37).

Methods

We performed a retrospective review of prospectively collected data in the National Trauma Data Bank (NTDB) from 2012–2016 (24). The NTDB is maintained by the American College of Surgeons (ACS) Committee on Trauma. It is publicly available and contains data submitted on a voluntary basis from over 900 registered trauma centers across the United States. The NTDB contains deidentified patient information including patient demographics, mechanism of injury, injury location and severity, admitting facility characteristics, treatment rendered, and discharge disposition. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The NTDB is a publicly available de-identified dataset so analysis is exempt from IRB review and no informed consent was obtained as it does not apply to the present study.

Patient selection

All patients aged 16 or older who presented to an ACS Certified Level I or II trauma center emergency department (ED) with any traumatic cervical or thoracic spine fractures treated at qualifying facilities were eligible for inclusion. The presence of a fracture in the cervical or thoracic spine, associated with SCI, was identified using ICD-9 diagnosis codes (Cervical = 806.0x, 806.1x; Thoracic = 806.2x, 806.3x). Eligible patients were excluded if they were dead on arrival or died in the ED; if they presented with major polytrauma [Injury Severity Score (ISS) ≥27] or a major injury to the head, thorax, or abdomen [Abbreviated Injury Scale (AIS) severity ≥3]; or if they did not have a complete set of baseline covariates necessary for inclusion in multivariate analysis.

Outcome

The primary outcome measure was surgical management of cervicothoracic fracture with SCI. We identified qualifying spine surgeries using ICD-9 CM procedure codes as described by Daly *et al.* (13).

Baseline demographic and other covariates

We included predictor variables in the following categories: sociodemographic, psychosocial, injury specific, and hospital characteristics.

Sociodemographic variables included age, gender, recorded race, and insurance status. Patients were categorized as Black, Hispanic, or White based on race and ethnicity variables. Patients who identified as Black were placed into the Black group regardless of Hispanic ethnicity. All other patients listed as Hispanic were placed in the Hispanic group. Other racial minority groups, such as Asian and Indian American, were excluded due to relatively low proportional representation in the NTDB (<0.5%). Insurance status was aggregated into private insurance (Blue Cross/Blue Shield, private/commercial insurance, workers compensation, other government, no fault automobile), Medicare, Medicaid, and uninsured (self-pay, no charge).

Psychosocial variables included the prior diagnosis of a major psychiatric disorder, alcoholism, or drug abuse; results of ED urine drug screen; results of ED serum drug screen; morbid obesity (BMI >40); and suicidal intent of trauma (*vs.* unintentional or assault).

Injury specific variables included mechanism of injury, type of injury, injury severity, fracture location, transfer status, and Glasgow Coma Scale (GCS) in the ED. Mechanism of injury is grouped broadly into several categories including motor vehicle collision, fall, gunshot wound, and others. Type of injury is broadly categorized as blunt *vs.* penetrating. Injury severity was assessed using the facility-reported ISS. Fracture location is grouped as cervical, thoracic, or cervicothoracic (≥1 cervical and ≥1 thoracic vertebral fractures) based on ICD-9/ICD-10 codes described above.

Admitting facility specific variables included hospital teaching status, hospital non-profit status, trauma level, and region.

Statistical analysis

We first analyzed baseline covariates between the cohorts of patients who did or did not receive a spine surgery using bivariate statistics (Pearson χ^2 test) to identify significant differences between the groups. A P value of <0.05 was considered significant. Bivariate logistic regression was then performed individually for all covariates and the outcome variable (surgical management) to determine independent association of each covariate with receiving spine surgery. Variables were selected for inclusion in the multivariate logistic regression model to predict spine surgery if they were both incident at ≥1% and significant at P<0.10 in bivariate logistic regression. Stata statistical software, version 16 (StataCorp LP, College Station, USA), was used for data management and statistical analyses.

Results

We identified 6,655 eligible patients for inclusion, of whom 62% underwent surgical treatment (N=4,137). *Figure 1* contains charts describing the incidence of each psychosocial and socioeconomic factor of interest within the entire study population. At baseline, patients treated operatively were significantly more likely to be younger; be male; be white; have private insurance; have had a urine drug screen (with any result, but even more so if the result was negative); have had a blood alcohol screen (with any result, but even more so if the result was negative); have had an unintentional injury; have been injured in a motor vehicle; have a cervical fracture; have a higher ISS; have a higher GCS in the ED; be at a for-profit hospital; and be in the Southern US. Psychosocial factors including major psychiatric disorder, a diagnosis of alcoholism, or a diagnosis of other substance

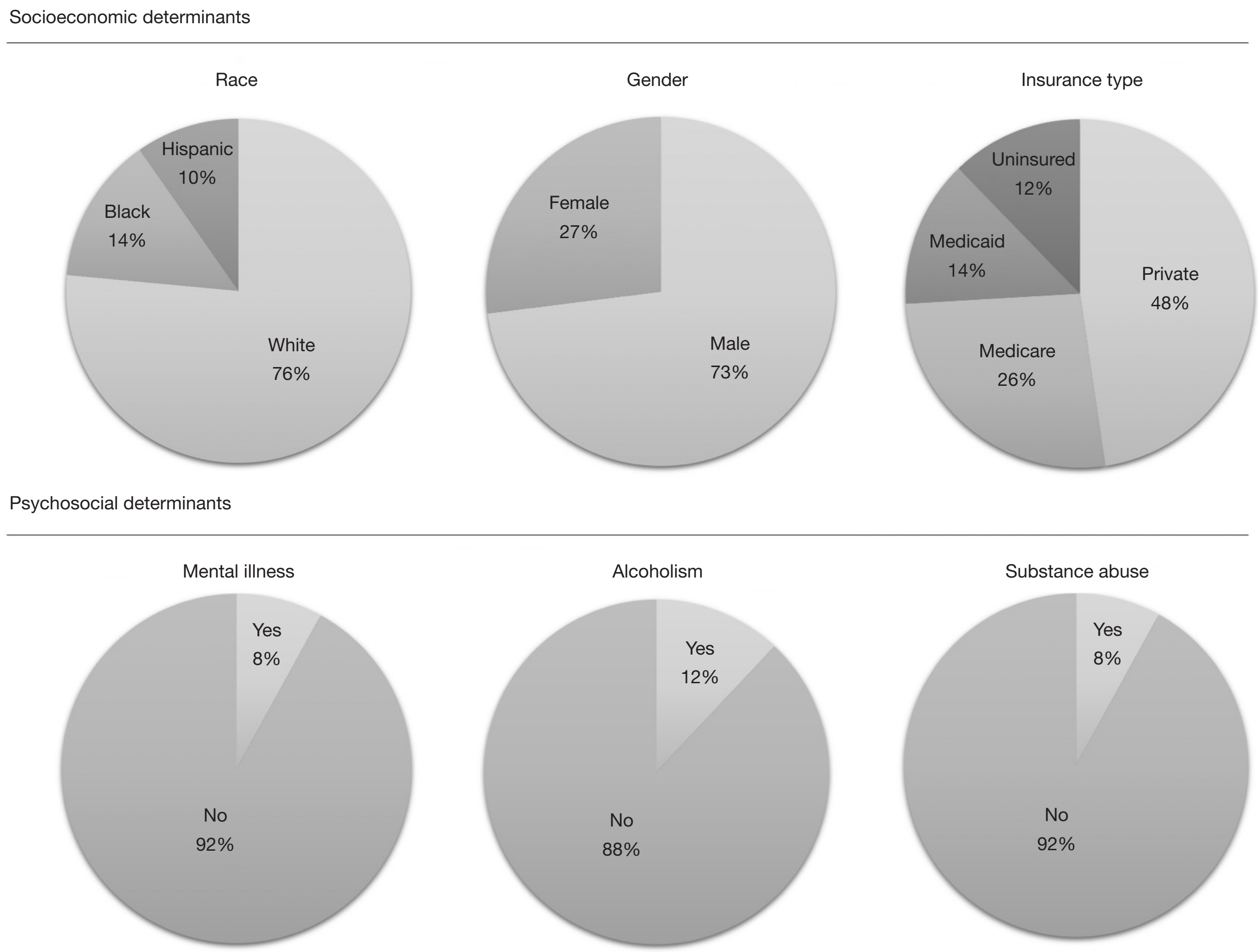

Figure 1 Baseline characteristics of study population.

abuse did not differ significantly between the treatment groups. These results are summarized in *Table 1*.

We then performed multivariate logistic regression to adjust for confounders. The psychosocial factors of major psychiatric disorder, a diagnosis of alcoholism, or a diagnosis of other substance abuse were not significant in univariate analysis and were not eligible for inclusion in the multivariate model. The only psychosocial or sociodemographic factor which remained significantly associated with operative treatment in multivariate analysis was insurance status: patients with Medicaid (OR 0.81; 95% CI: 0.68–0.97; P=0.021) and no insurance (OR 0.63; 95% CI: 0.52–0.75); P<0.001) had significantly lower odds of surgical treatment. Other variables of interest, including gender and race, showed trends which suggested a preference toward male and white patients in surgical treatment, but these variables did not reach significance in multivariate analysis (*Table 2*).

Discussion

Managing traumatic cervicothoracic fracture with SCI can be challenging, and evidence suggests that patients with biomechanical instability or neurological deficit may benefit from surgical intervention (25). However, it is unclear whether or how sociodemographic and psychosocial factors affect surgical decision making for these patients. We attempted to identify relationships between these factors and the decision to operate to better understand how these factors affect healthcare access and utilization in this acute population.

Many significant differences in baseline characteristics

Table 1 Comparison of sociodemographic, psychosocial, injury, and facility covariates between the populations of patients with traumatic cervicothoracic fracture with SCI by treatment group

Characteristic	No Surgery, n=2,518 (37.8%)	Surgery, n=4,137 (62.2%)	P value
Age, years			<0.001*
16–25	407 (16.2)	776 (18.8)	
26-45	483 (19.2)	1,081 (26.1)	
46–65	750 (29.8)	1,349 (32.6)	
66–75	331 (13.1)	513 (12.4)	
>75	547 (21.7)	418 (10.1)	
Gender, male	1,779 (70.7)	3,090 (74.7)	<0.001*
Race			<0.001*
White	1,853 (73.6)	3,237 (78.2)	
Hispanic	267 (10.6)	380 (9.2)	
Black	398 (15.8)	520 (12.6)	
Insurance status			<0.001*
Private	996 (39.6)	2,176 (52.6)	
Medicare	811 (32.2)	947 (22.9)	
Medicaid	368 (14.6)	542 (13.1)	
Uninsured	343 (13.6)	472 (11.4)	
Major psychiatric disorder	196 (7.8)	362 (8.8)	0.168
Alcoholism	290 (11.5)	513 (12.4)	0.283
Other substance abuse	207 (8.2)	334 (8.1)	0.831
Urine drug screen			0.007*
Negative	437 (17.4)	849 (20.5)	
Illegal drug	293 (11.6)	487 (11.8)	
Prescription drug	149 (5.9)	232 (5.6)	
Illegal + Rx drug	42 (1.7)	92 (2.2)	
Not tested/reported	1,597 (63.4)	2,477 (59.9)	
Blood alcohol level			<0.001*
Above legal limit	950 (37.7)	1,639 (39.6)	
Trace detected	144 (5.7)	241 (5.8)	
Tested negative	351 (13.9)	766 (18.5)	
Untested/unreported	1,073 (42.6)	1,491 (36.0)	
Intent of injury			<0.001*
Unintentional	2,186 (86.8)	4,012 (97.0)	
Assault	316 (12.5)	104 (2.5)	
Self-inflicted	16 (0.6)	21 (0.5)	

Table 1 (*continued*)

Table 1 (*continued*)

Characteristic	No Surgery, n=2,518 (37.8%)	Surgery, n=4,137 (62.2%)	P value
Mechanism of injury			<0.001*
Motor vehicle driver/occupant	771 (30.6)	1,533 (37.1)	
Pedestrian	47 (1.9)	65 (1.6)	
Other transportation	203 (8.1)	429 (10.4)	
Fall	1,082 (43.0)	1,821 (44.0)	
Struck by/against	87 (3.5)	193 (4.7)	
Other/unclassified	328 (13.0)	96 (2.3)	
Injury type			<0.001*
Blunt	2,201 (87.4)	4,059 (98.1)	
Penetrating	317 (12.6)	78 (1.9)	
Fracture location			<0.001*
Cervical	1,418 (56.3)	2,622 (63.4)	
Thoracic	776 (30.8)	991 (24.0)	
Cervicothoracic	324 (12.9)	524 (12.7)	
Injury Severity Score			<0.001*
Minor [1–8]	155 (6.2)	60 (1.5)	
Moderate [9–15]	934 (37.1)	1,105 (26.7)	
Severe [16–26]	1,429 (56.8)	2,972 (71.8)	
GCS total in ED			<0.001*
12–15	2,167 (86.1)	3,765 (91.0)	
9–11	74 (2.9)	97 (2.3)	
3–8	277 (11.0)	275 (6.6)	
Transfer, yes	895 (35.5)	1,566 (37.9)	0.058
Hospital teaching status			0.898
University	1,634 (64.9)	2,691 (65.0)	
Community	884 (35.1)	1,446 (35.0)	
Hospital type, for-profit	192 (7.6)	395 (9.5)	0.007*
Hospital region			<0.001*
Midwest	731 (29.0)	1,212 (29.3)	
Northeast	368 (14.6)	503 (12.2)	
South	789 (31.3)	1,485 (35.9)	
West	630 (25.0)	937 (22.6)	
ACS trauma level			0.053
I	1,808 (71.8)	3,060 (74.0)	
II	710 (28.2)	1,077 (26.0)	

All comparisons made using Pearson's χ^2 test. Values presented as n. *, significant values (P<0.05). SCI, spinal cord injury; ACS, American College of Surgeons.

Table 2 Results of multivariate analysis to assess factors associated with surgical management of traumatic cervicothoracic spine fracture with SCI

Variable	Odds ratio	95% CI	P value
Age			
16–25	1	(Base)	(Base)
26–45	0.93	0.77–1.12	0.456
46–65	0.58	0.48–0.69	<0.001*
66–75	0.47	0.37–0.60	<0.001*
>75	0.24	0.19–0.30	<0.001*
Gender			
Female	1	(Base)	(Base)
Male	1.11	0.98–1.26	0.093
Race			
White	1	(Base)	(Base)
Hispanic	0.87	0.71–1.06	0.159
Black	0.95	0.80–1.14	0.597
Insurance status			
Private	1	(Base)	(Base)
Medicare	0.88	0.74–1.05	0.147
Medicaid	0.81	0.68–0.97	0.021*
Uninsured	0.63	0.52–0.75	<0.001*
ED drug test			
Negative	1	(Base)	(Base)
Illegal drug	1.05	0.85–1.29	0.661
Rx drug	0.95	0.74–1.23	0.715
Both	1.35	0.88–2.07	0.167
Not tested/reported	1.04	0.89–1.22	0.627
ED blood alcohol			
Negative	1	(Base)	(Base)
Trace	0.96	0.75–1.23	0.751
Above limit	1.00	0.85–1.18	0.990
Not tested/reported	0.86	0.75–0.99	0.040*
Intent			
Unintentional	1	(Base)	(Base)
Intentional (assault or self-harm)	0.66	0.42–1.02	0.063
Mechanism			
Motor vehicle driver/occupant	1	(Base)	(Base)
Pedestrian	0.81	0.54–1.22	0.313

Table 2 (*continued*)

Table 2 (*continued*)

Variable	Odds ratio	95% CI	P value
Other transportation	1.04	0.85–1.27	0.727
Fall	1.21	1.06–1.39	0.005*
Struck by/against	1.21	0.89–1.64	0.219
Other/unclassified	0.75	0.34–1.64	0.470
Injury type			
Blunt	1	(Base)	(Base)
Penetrating	0.17	0.07–0.42	<0.001*
Fracture region			
Cervical	1	(Base)	(Base)
Thoracic	0.82	0.72–0.94	0.004*
Cervicothoracic	0.75	0.64–0.89	0.001*
Injury Severity Score			
Minor [1–8]	1	(Base)	(Base)
Moderate [9–15]	3.17	2.29–4.37	<0.001*
Severe [16–26]	6.58	4.78–9.05	<0.001*
Glasgow Coma Scale (total) in ED			
12–15	1	(Base)	(Base)
9–11	0.66	0.47–0.92	0.015*
3–8	0.51	0.42–0.62	<0.001*
Transfer patient			
No	1	(Base)	(Base)
Yes	1.10	0.98–1.24	0.095
Hospital type			
Non-profit	1	(Base)	(Base)
For profit	1.38	1.13–1.70	0.002*
Region			
Midwest	1	(Base)	(Base)
Northeast	0.80	0.67–0.96	0.016*
South	1.16	1.01–1.34	0.036*
West	0.90	0.77–1.05	0.182
ACS trauma level			
I	1	(Base)	(Base)
II	0.89	0.78–1.01	0.068

*, significant values (P<0.05). SCI, spinal cord injury; ED, emergency department; ACS, American College of Surgeons.

existed between the treatment groups, including socioeconomic factors like gender, race, and insurance status. However, after adjusting for covariates in multivariate analysis, only insurance status remained significant. This suggests that baseline differences in socioeconomic factors, other than insurance type, are related to covariates which better account for differences in the decision to operate. Notably, while we were not able to account for factors not otherwise recorded in this multi-institutional national database, one of the strengths of our analysis is therefore that we accounted for all relevant variables to which we had access, which strengthens the key findings of our analysis.

Indeed, we found that independent of other considered factors, patients on Medicaid and uninsured patients were significantly less likely to receive surgical treatment for traumatic cervicothoracic fracture with SCI than patients with private insurance; however, Medicare patients had similar odds of surgery as patients with private insurance. This suggests that the type and quality of insurance affects healthcare utilization even in patients with acute SCI. While perhaps surprising in this study population, bias against Medicaid and uninsured patients has been observed widely in medicine. Similar findings have been described in outcomes following acute coronary syndrome, lung transplant, head and neck cancer, and major surgery (26-28). Daly *et al.* found that surgery rates were tied to presence of insurance following SCI (13), but the present study builds upon the literature by revealing that is not just presence of insurance, but rather the type of insurance that is important in surgical decision making following traumatic SCI.

Sociodemographic factors also have been found to influence outcome in patients with spine trauma. Using the NTDB, Schoenfeld and colleagues found that patients who were nonwhite had an increased risk of mortality and that those without insurance had an increased risk of mortality and decreased number of hospital days, ICU days, and ventilator time following spine trauma (29). Other research has supported the finding that following trauma, patients without insurance stay in the hospital fewer days and have worse outcomes compared to their privately insured counterparts (30,31). Chen *et al.* found that patients who were Black and those with non-private insurance were more likely to be readmitted following spine surgery (32). Additionally, those uninsured are less likely to be discharged to a rehab facility following SCI (33). The present research question was informed by this previous work showing disparate outcomes following spine trauma with the aim of assessing potential effectors of this inequality. By identifying insurance status as an independently significant predictor despite the emergent nature of spinal injury, our results suggest that there may be significant distinguishing factors not specifically captured in this analysis which distinguish these groups and/or the quality of care they receive, perhaps related to health literacy, implicit provider bias, and the informed consent process itself.

In the US, uninsured or underinsured adults are less than half as likely to receive necessary medical care because of costs compared with well-insured patients (34). While the effect is likely multifactorial (35), providers may choose more conservative treatment modalities for patients with expected high out-of-pocket costs (36). Conversely, high cost also influences patient decision making, and underinsured patients often forgo necessary medical care due to cost concerns (37). Whether explicitly acknowledged or not, these factors may influence surgical decision making towards favoring conservative treatments options for underinsured patients when the patients' own perception of anticipated cost is accounted for. Limited patient health literacy may also contribute to a decision to pursue conservative treatment options as it is associated with adverse surgical outcomes (38,39). In addition to health literacy, mistrust among some minority populations that have been historically exploited by the medical system in the United States may also underpin disparities in how different patient populations approach informed consent—some patients may require additional counseling when making an informed decision regarding whether to pursue surgery. Additionally, it is possible that inherent biases within the care team lead to less culturally competent care to lower income groups like those with Medicaid or uninsured. Indeed, it seems more likely that the source of the bias detected in the present study is more nuanced than that seen in elective or non-emergent surgery settings, where a patient may not undergo surgery because providers choose not to accept Medicaid or to treat those without insurance (40). This makes our present findings particularly interesting, since one might expect equitable treatment following spinal injury to be guaranteed when reimbursement considerations in such settings should theoretically be eliminated by the Emergency Medical Treatment and Labor Act (EMTALA).

We did not find that other sociodemographic or psychosocial factors remained significantly associated with odds of surgical management. Rates of the studied psychosocial factors were similar between the groups at baseline and did not qualify for inclusion in the multivariate model. These factors may not independently factor into provider decision making in the emergency setting. Alternatively, it is possible that in the trauma setting, these potential sources of bias are unknown if a patient is unable to provide their medical history and is not acutely demonstrating behaviors concerning for psychiatric illness.

Women and patients who identify as Black or Hispanic did have lower odds of surgical management after adjusting for other covariates, but these results did not reach statistical significance. Previous literature has focused on how race and ethnicity contribute to disparate rates of medical treatment by way of provider and system-wide bias (36,41-48). The role of provider bias has been found to extend to surgical procedures as well, although this effect has been primarily documented in elective (non-emergent) surgery (15-17). Our results suggest that the association of race with surgical management following spine trauma is not as pronounced as it is in elective surgery and other outpatient medical care, possibly due to more standardized decision-making and care pathways for trauma patients. However, racial bias in acute SCI management may be more implicit within our systems of critical care delivery by means of insurance status as Black or Hispanic are disproportionately represented among insurance groups (49).

Limitations

The NTDB is a voluntary database susceptible to missing coding data leading to sampling bias, which potentially limits the study's generalizability to only those institutions who voluntarily submit data. We focused on academic ACS Level I and II institutions, which are generally larger hospital systems with younger and more critically ill patients than the national trauma population. While the NTDB is a particularly large database powered to answer our question about the effects of the sociodemographic and psychosocial factors we discussed, it does not contain all variables to evaluate surgical decision making. The NTDB does not contain an ideal set of variables to determine objectively in which instances surgery was indicated and justified and in which cases conservative management would have been appropriate. For example, the dataset lacks granularity with regard to variables like the type of spinal fracture, spinal stability, and type of SCI. Furthermore, the database does not account for SCI-specific variables such as ASIA score with which to stratify severity of neurologic injury. This lack of granularity may conceal potential confounding variables that we were unable to account for within the regression models. Future studies should include a prospective survey of patient decision-making factors when engaged with their clinician regarding treatment options following an injury, as well as correcting for SCI-specific covariates.

Conclusions

Psychosocial factors such as the diagnosis of alcoholism, substance abuse, or psychiatric illness did not appear to bias the decision to operate following traumatic cervicothoracic fracture with SCI. After adjusting for potential cofounders, the only sociodemographic or psychosocial factor independently associated with odds of surgery after cervicothoracic fracture with SCI was health insurance status, with Medicaid and uninsured patients having lower odds of receiving surgery. More research is needed into the effects of insurance status before broad policy changes should be enacted.

Acknowledgments

Funding: None.

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://dx.doi.org/10.21037/jss-21-37

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://dx.doi.org/10.21037/jss-21-37). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

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Cite this article as: Hagan MJ, Pertsch NJ, Leary OP, Zheng B, Camara-Quintana JQ, Niu T, Mueller K, Boghani Z, Telfeian AE, Gokaslan ZL, Oyelese AA, Fridley JS. Influence of psychosocial and sociodemographic factors in the surgical management of traumatic cervicothoracic spinal cord injury at level I and II trauma centers in the United States. J Spine Surg 2021;7(3):277-288. doi: 10.21037/jss-21-37

