Racial and ethnic disparities in discharge to rehabilitation following traumatic brain injury

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OBJECT Disparities in access to inpatient rehabilitation services after traumatic brain injury (TBI) have been identified, but less well described is the likelihood of discharge to a higher level of rehabilitation for Hispanic or black patients compared with non-Hispanic white patients. The authors investigate racial disparities in discharge destination (inpatient rehabilitation vs skilled nursing facility vs home health vs home) following TBI by using a nationwide database and methods to address racial differences in prehospital characteristics.

METHODS Analysis of discharge destination for adults with moderate to severe TBI was performed using National Trauma Data Bank data for the years 2007–2010. The authors performed propensity score weighting followed by ordered logistic regression in their analytical sample and in a subgroup analysis of older adults with Medicare. Likelihood of discharge to a higher level of rehabilitation based on race/ethnicity accounting for prehospital and in-hospital variables was determined.

RESULTS The authors identified 299,205 TBI incidents: 232,392 non-Hispanic white, 29,611 Hispanic, and 37,202 black. Propensity weighting resulted in covariate balance among racial groups. Hispanic (adjusted OR 0.71, 95% CI 0.68–0.75) and black (adjusted OR 0.94, 95% CI 0.91–0.97) populations were less likely to be discharged to a higher level of rehabilitation than were non-Hispanic whites. The subgroup analysis indicated that Hispanic (adjusted OR 0.79, 95% CI 0.71–0.86) and black (OR 0.87, 95% CI 0.81–0.94) populations were still less likely to receive a higher level of rehabilitation, despite uniform insurance coverage (Medicare).

CONCLUSIONS Adult Hispanic and black patients with TBI are significantly less likely to receive intensive rehabilitation than their non-Hispanic white counterparts; notably, this difference persists in the Medicare population (age ≥ 65 years), indicating that uniform insurance coverage alone does not account for the disparity. Given that insurance coverage and a wide range of prehospital characteristics do not eliminate racial disparities in discharge destination, it is crucial that additional unmeasured patient, physician, and institutional factors be explored to eliminate them.

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KEY WORDS trauma; traumatic brain injury; disparities; level of rehabilitation

TRAUMATIC brain injury (TBI) is increasing in incidence in the US. Approximately 1.7 million TBIs occur annually; the majority of these patients are evaluated and discharged from the emergency department; however, 275,000 are hospitalized with moderate to severe TBI and survive to discharge.⁵ A TBI can result in

long-term functional loss, which then increases the burden on family support systems and societal resources.^{1,5} Prior studies have shown that minority patients are at an increased risk for TBI compared with the non-Hispanic white (NHW) population.^{8,9,17} After discharge from acute hospitalization, both outpatient and inpatient rehabilita-

ABBREVIATIONS AIS-H = Abbreviated Injury Score for the head; ASAMD = absolute standardized average mean differences; GCS-M = Glasgow Coma Scale–Motor; ICU = intensive care unit; IPTW = inverse probability of treatment assignment weighting; IR = inpatient rehabilitation; ISS = Injury Severity Score; LOS = length of stay; MOI = mechanism of injury; NHW = non-Hispanic white; NTDB RDS = National Trauma Data Bank Research Data Set; SNF = skilled nursing facility; TBI = traumatic brain injury.

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tion (less and more intensive rehabilitation, respectively) have been shown to improve functional status in a large proportion of patients.^{10,16,21}

Race-based and insurance-based disparities in access to inpatient rehabilitation have been demonstrated in several studies;^{1,7,19,20} however, most of these studies variously included only inpatient rehabilitation (IR) as an outcome, excluded older adults, or were limited by their database and statistical methodology.^{3,7,18} Frequently, studies classify non-IR discharge destinations as equivalent outcomes (e.g., home or skilled nursing facility [SNF]). Unfortunately, these previous studies have not adequately accounted for the ordered nature of discharge destinations. We posit that discharge destination should be considered in light of the spectrum of rehabilitative services offered. The lowest level of the spectrum is home, in which no services are offered; the next level is home health, with outpatient or in-home services; this is followed by SNF; and the highest level of rehabilitation is IR. Hispanic and black patients with comparable injuries and rehabilitation needs who are discharged to a level of rehabilitation lower than that of NHW patients are likely to have worse functional outcomes and require more long-term community resources.^{4,16} The opportunity exists to reduce long-term sequelae as well as to improve functional status and outcomes in patients with TBI when higher levels of rehabilitative therapy are offered.

Little is known concerning the influence of race and ethnicity on discharge disposition for older adults with TBI. This injury disproportionately affects older adults, with incidence rising during the 6th decade of life.⁵ As the population of the US ages, TBI is a significant source of morbidity and decreased functionality. Patients ≥ 65 years old have frequently been excluded from analyses, because it was thought that the uniformity of insurance coverage would decrease the disparity. However, if the disparity in discharge destination is absent or decreased in a group of older adults with uniform coverage, then this suggests a target of opportunity with policy implications for reducing this disparity in the larger population. Exploring the potential disparity in all levels of rehabilitative therapy is a significant, clinically relevant, and timely endeavor.

In this study we hypothesized that racial and ethnic disparities exist in the likelihood of discharge to a higher level of rehabilitation. Additionally, we hypothesized that the subgroup of Medicare beneficiaries ≥ 65 years old who have moderate to severe TBI would have less disparity due to the uniformity of insurance coverage.

Methods

Study Design, Data Source, and Study Population

This retrospective cohort study used data from the National Trauma Data Bank Research Data Set (NTDB RDS) for the years 2007–2010. The NTDB is a voluntary repository of de-identified trauma registry data from across the US and is maintained by the American College of Surgeons. These years were chosen specifically to include only years in which the NTDB used the National Trauma Data Standard, representing a marked improvement in data reliability and fidelity. Additionally, all

American College of Surgeons–verified trauma centers were required to submit information in accordance with the National Trauma Data Standard beginning in 2007.⁷

The initial analytical sample included observations in patients older than 18 years with an Abbreviated Injury Score for the head (AIS-H) of 2–5 who survived to discharge. Patients with injuries with an AIS-H of 1, representing minor injury, and injuries with an AIS-H of 6, representing fatal injuries by definition, were excluded. Patients who had an undocumented discharge destination, were discharged to another acute care hospital or to hospice, or who left against medical advice were also excluded. Patients with missing race information were then excluded. The sample was limited to individuals coded as NHW, Hispanic, or black, because of the small sample size in other racial categories. Patients in whom data were missing on insurance status, Glasgow Coma Scale–Motor (GCS-M), Injury Severity Score (ISS), mechanism of injury (MOI), sex, and length of stay (LOS) were excluded as well.

Control Variables and Outcome Measure

Patient data for analysis included the following: age; sex; race/ethnicity; insurance status (self-pay, Medicare, Medicaid, private, third-party payer, other); MOI (blunt, penetrating, other); ISS (range 6–75); AIS-H score (range 2–5); GCS-M score (range 1–6); LOS; days in the intensive care unit (ICU); and days on a ventilator. The primary exposure variable was race/ethnicity status, operationalized as one of three mutually exclusive categories: NHW, Hispanic, or black.

The outcome of interest in this study was discharge destination. Observations were categorized into one of four mutually exclusive discharge categories: IR; SNF; home with home health services; and home. These categories represent decreasing levels of care at discharge and, to some degree, decreasing potential intensity of rehabilitation services available to an individual.

Statistical Analysis

Differences among NHW, Hispanic, and black groups were compared using the Pearson chi-square test for categorical variables and ANOVA for continuous variables in unadjusted cohorts. We also calculated absolute standardized average mean differences (ASAMD) to compare covariate imbalance before and after the adjustment was made using propensity score weighting.

Complex relationships between race/ethnicity, observed control variables, and outcome measures significantly increase the potential for bias in underspecified or misspecified multivariable models. Therefore this study used a multiassignment propensity score, estimated via a multinomial logistic regression, to derive the conditional probability of assignment according to race/ethnicity category (NHW, Hispanic, or black) given the observed prehospital variables. Inverse probability of treatment assignment weighting (IPTW) was performed to achieve balance among race/ethnicity categories for selected prehospital variables. The prehospital variables included age, sex, insurance status, MOI, AIS-H score, GCS-M score, and

ISS—after a literature review, our confounding variables for inclusion in the IPTW were decided a priori because these are associated with the outcome (discharge destination) and exposure (race). The ASAMD was compared between the unweighted and IPTW groups to assess balance. Following IPTW and balance assessment, ordered logistic regression was used to estimate odds ratios for discharge to a higher level of rehabilitation, with IR being the highest and home being the lowest level of rehabilitation. The regression was adjusted with in-hospital covariates (LOS, days in the ICU, and days on a ventilator) that were found to be associated with the outcome, and included robust clustered (hospital) standard errors to account for repeated observations within facilities.

A subgroup analysis was completed in patients ≥ 65 years old who were Medicare beneficiaries, using the same statistical methods. All analysis was completed using STATA software (Version 12; StataCorp). The a priori level of statistical significance was set at $p < 0.05$ for all

analyses. The study was reviewed and deemed exempt by the university's institutional review board.

Results

The NTDB for 2007–2010 contained 7,618,816 incidents, of which there were 435,376 incidents in patients older than 18 years with an AIS-H score of 2–5 and a discharge destination of interest. In 17,870 incidents no race or ethnicity was recorded, 31,811 incidents were classified as other racial or ethnic minorities, and 96,445 were missing data in at least one variable; these incidents were excluded. After these exclusions, the final study population consisted of 299,205 incidents (Fig. 1).

The mean age of the study population was 48 ± 21 years (mean $\pm$ SD), with a majority being white (77%), male (67%), diagnosed with blunt injury (94%), and discharged home (71%). Hispanic (82%) and black (77%) patients were more likely to be discharged home than NHW

FIG. 1. Algorithm showing study population and exclusion criteria.

TABLE 1. Prehospital and clinical characteristics of patients with moderate to severe TBI by race*

Characteristic	Overall	NHW	Hispanic	Black	p Value†
No. of patients	299,205	232,392	29,611	37,202	
Mean age in yrs, $\pm$ SD	48.2 $\pm$ 21.1	50.4 $\pm$ 21.5	38.9 $\pm$ 17.6	41.8 $\pm$ 17.4	<0.001
Male sex	200,452 (67)	149,721 (64.4)	23,107 (78)	27,624 (74.3)	<0.001
Payer source					<0.001
Private	92,309 (30.9)	77,275 (33.3)	6553 (22.1)	8481 (22.8)	
Medicare	67,842 (22.7)	60,346 (26)	2700 (9.1)	4796 (12.9)	
Self-pay	56,101 (18.8)	34,628 (14.9)	10,011 (33.8)	11,462 (30.8)	
3rd party	33,492 (11.2)	26,768 (11.5)	3381 (11.4)	3343 (9)	
Medicaid	28,786 (9.6)	18,360 (7.9)	3943 (13.3)	6483 (17.4)	
Other	20,675 (6.9)	15,015 (6.5)	3023 (10.2)	2637 (7.1)	
ISS					<0.001
Mild; $\leq$ 8	71,336 (23.8)	52,876 (22.8)	7155 (24.2)	11,305 (30.4)	
Moderate; 9–14	91,408 (30.6)	71,072 (30.6)	9161 (30.9)	11,175 (30)	
Severe; 15–25	98,505 (32.9)	78,535 (33.8)	9350 (31.6)	10,620 (28.5)	
Extremely severe; $\geq$ 26	37,956 (12.7)	29,909 (12.9)	3945 (13.3)	4102 (11)	
median GCS-M score (IQR)	6 (0)	6 (0)	6 (0)	6 (0)	0.001
median AIS-H (IQR)	3 (2)	3 (2)	3 (2)	3 (2)	0.001
MOI					<0.001
Blunt	283,083 (94.6)	223,406 (96.1)	26,949 (91)	32,728 (88)	
Penetrating	5608 (1.9)	2289 (1)	1072 (3.6)	2247 (6)	
Other/unspecified	10,514 (3.5)	6697 (2.9)	1590 (5.4)	2227 (6)	
Discharge destination					<0.001
Home	212,151 (70.9)	159,280 (68.5)	24,356 (82.3)	28,515 (76.6)	
Home w/ HH	11,523 (3.9)	9388 (4)	711 (2.4)	1424 (3.8)	
SNF	42,161 (14.1)	36,082 (15.5)	1917 (6.5)	4162 (11.2)	
IR	33,370 (11.2)	27,642 (11.9)	2627 (8.9)	3101 (8.3)	
Mean LOS in days, $\pm$ SD	7.3 $\pm$ 10.8	7.2 $\pm$ 10.1	8.0 $\pm$ 13.2	8.0 $\pm$ 13.0	<0.001
Mean ICU days, $\pm$ SD	2.8 $\pm$ 6.2	2.7 $\pm$ 6.0	3.0 $\pm$ 6.9	2.9 $\pm$ 6.9	<0.001
Mean vent days $\pm$ SD	1.3 $\pm$ 4.9	1.3 $\pm$ 4.7	1.4 $\pm$ 5.0	1.5 $\pm$ 5.5	<0.001

HH = home health care; IQR = interquartile range; vent = ventilator.

* Unless otherwise specified, values are expressed as number of patients (%).

† The p values were calculated using ANOVA for continuous variables, Kruskal-Wallis for ordinal variables, and chi-square test for binary/categorical variables (significant at $p < 0.05$).

(69%). Conversely, NHW individuals (12%) were more likely to be discharged to IR than Hispanic (9%) and black (8%) individuals ($p < 0.001$) (Table 1).

Following IPTW for age, sex, ISS, AIS-H score, GCS-M score, MOI, and payer source, the ASAMD for the adjusted sample was significantly improved in most covariates and below the suggested 10% threshold in all covariates. Figure 2 demonstrates the balance in our unadjusted and propensity-weighted samples.

According to ordered logistic regression on the IPTW-adjusted sample, black (OR 0.94, 95% CI 0.91–0.97) and Hispanic (OR 0.71, 95% CI 0.68–0.75) individuals were significantly less likely than NHW to be discharged to a higher level of rehabilitation (Table 2).

Unadjusted demographic data in our subgroup analysis for Medicare beneficiaries ≥ 65 years old ($n = 56,235$) are displayed in Table 3. The average age was 77.9 ± 6.9 years, 91% were NHW, and 52.6% were female. The MOI was blunt in 98.3%, and 52.3% had an ISS ≥ 16 . Only 44% were

discharged home. Following IPTW, balance was achieved in the covariates as previously described. The ordered logistic regression demonstrated that the disparity persisted, with Hispanic (OR 0.79, 95% CI 0.71–0.86) and black (OR 0.87, 95% CI 0.81–0.94) patients significantly less likely than NHW patients to be discharged to a higher level of rehabilitation (Table 4).

Discussion

There are population-specific differences in the presence of disease, health outcomes, quality of health care, and access to health care services that exist across racial and ethnic groups in the US.¹³ As the US becomes more diverse in the coming decades, efficiencies in health care delivery will not be achieved unless health care disparities are addressed. In this study we demonstrated the existence of disparities in discharge destination in the TBI population. We found that Hispanic and black patients were sig-

FIG. 2. Scatter plot showing cohort differences before and after weighting. Balance between NHW and Hispanic above, and NHW and black below. The dashed line represents 10% ASAMD.

nificantly less likely to be discharged to a higher level of rehabilitation than similarly matched NHW patients. This disparity persisted in our subgroup examination of older adults with uniform Medicare coverage.

Previously, Shafi et al. demonstrated that minority patients were less likely to be discharged to IR; however, the study did not include other discharge destinations within the analysis, and minority status was binary.¹⁸ Englum et al. interacted race with insurance status, finding Hispanic and black patients were less likely to be discharged to any form of rehabilitation.⁷ However, this study excluded patients ≥ 65 years old and did not account for the ordered nature of discharge destination. Our study advances prior knowledge by explicitly accounting for the inherently ordered spectrum of rehabilitative services in discharge destinations. This study is the first to demonstrate that not only are minority patients with TBI less likely to be discharged to IR, they are in fact less likely to be discharged to a concordant level of rehabilitation than their matched NHW counterparts. In addition, this study is the first to demonstrate that these racial and ethnic disparities persist

in a population of older adults with TBI despite coverage by uniform public insurance.

The limitations of working with a large retrospective administrative database include selection or reporting bias—we were unable to account for unobserved or unrecorded patient or location characteristics. Socioeconomic indicators are not available in this data set, although we did use insurance status, a known marker for socioeconomic status, in our IPTW analysis. Additional data such as secondary insurance, geographic location, and hospital-level characteristics may be useful, but these are not captured within the NTDB. However, given the analytical sample size and the robustness of our estimates, these unobserved characteristics would need to be a strong risk factor for a lower level of care and exhibit a strong imbalance in distribution among race/ethnicity categories to mitigate our findings.

Another limitation of our study is missing data; 22% of our study cohort was dropped because of missing variables. Previous studies have used multiple-imputation techniques to manage missing data by mirroring a complete data set.¹¹ However, this method relies heavily on the assumption that the data are missing at random. In our preliminary analysis we found strong evidence that our data were not missing at random; therefore multiple-imputation techniques could not be used in this study. To minimize these sources of bias, we chose to implement IPTW for race/ethnicity status and complete case analysis in our propensity score and outcome models, therefore substantially reducing the potential for bias in our estimates. Another limitation is the classification of race and ethnicity itself. In this data set, race and ethnicity may not be self-assigned, but rather administratively conferred,

TABLE 2. Adjusted odds of discharge to a higher level of rehabilitation in patients with TBI

Factor	OR	95% CI	p Value
NHW	1.0	Reference	—
Hispanic	0.714	0.683–0.746	<0.001
Black	0.936	0.905–0.967	<0.001
LOS in days	1.051	1.048–1.054	<0.001
ICU days	1.092	1.086–1.099	<0.001
Vent days	0.962	0.957–0.968	<0.001

TABLE 3. Prehospital and clinical characteristics of patients with moderate to severe TBI by race in Medicare beneficiaries ≥ 65 years old*

Characteristic	Overall	NHW	Hispanic	Black	p Value†
No. of patients	56,235	51,366	2014	2855	
Mean age in yrs, ± SD	77.9 ± 6.9	78.1 ± 6.9	76.1 ± 6.8	75.8 ± 7.1	<0.001
Male sex	26,654 (47.4)	24,011 (46.7)	1043 (51.8)	1600 (56)	<0.001
ISS					<0.001
Mild; ≤8	9525 (16.9)	8646 (16.8)	319 (15.8)	560 (19.6)	
Moderate; 9–14	17,227 (30.6)	15,831 (30.8)	568 (28.2)	828 (29)	
Severe; 15–25	24,894 (44.3)	22,681 (44.2)	950 (47.2)	1263 (44.2)	
Extremely severe; ≥26	4589 (8.2)	4208 (8.2)	177 (8.8)	204 (7.1)	
median GCS-M score (IQR)	6 (0)	6 (0)	6 (0)	6 (0)	0.001
median AIS-H (IQR)	4 (1)	4 (1)	4 (1)	4 (1)	0.082
MOI					<0.001
Blunt	55,300 (98.3)	50,577 (98.5)	1958 (97.2)	2765 (96.8)	
Penetrating	138 (0.2)	123 (0.2)	4 (0.2)	11 (0.4)	
Other/unspecified	797 (1.4)	666 (1.3)	52 (2.6)	79 (2.8)	
Discharge destination					<0.001
Home	25,044 (44.5)	22,664 (44.1)	1049 (52.1)	1331 (46.6)	
Home w/ HH	3601 (6.4)	3289 (6.4)	119 (5.9)	193 (6.8)	
SNF	18,982 (33.8)	17,501 (34.1)	513 (25.5)	968 (33.9)	
IR	8608 (15.3)	7912 (15.4)	333 (16.5)	363 (12.7)	
Mean LOS in days, ± SD	6.9 ± 7.4	6.8 ± 7.2	7.5 ± 8.6	7.9 ± 9.1	<0.001
Mean ICU days, ± SD	2.4 ± 4.8	2.3 ± 4.8	2.9 ± 5.4	2.7 ± 5.2	<0.001
Mean vent days, ± SD	0.8 ± 3.5	0.8 ± 3.5	0.9 ± 3.9	0.9 ± 3.9	0.005

* Unless otherwise specified, values are expressed as number of patients (%).

† The p values were calculated using ANOVA for continuous variables, Kruskal-Wallis for ordinal variables, and chi-square test for binary/categorical variables.

therefore introducing uncontrollable sources of error. Finally, the NTDB is an incident-level registry rather than a patient-level registry; thus we were unable to identify and control for patients with multiple traumatic events who may be represented in the database multiple times.

Historically, health care disparities among minorities have been regarded as a marker for socioeconomic status, with insurance status tightly intertwined in the outcome.^{2,14} Yet, we have shown that even in a uniformly insured (Medicare) population ≥ 65 years old, this disparity persists. This has significant economic implications at the societal level as well as cognitive and functional implications at the patient level.⁶ There are numerous unexplained variables that probably play significant roles in this disparity, including sociocultural norms and family support systems as well as

physician and patient expectations. Patients and families may believe that they can be best cared for at home, rather than in a facility; however, patients with TBI may be less functional at home, relying heavily on others (particularly their immediate family) for assistance with activities of daily living.⁶ This results in decreased contributions to the workforce by not only the patient but also their primary caretaker. The resulting economic burden to the individual, family, and society is significant.^{6,12} Importantly, physicians and therapists may inadequately communicate the benefits of rehabilitation and the differences in the discharge destinations.¹ Physician attitudes, cultural competency, and real or perceived expectations of functional prognosis must be considered as sources for this disparity.

Conclusions

With the changing health care paradigm and the implementation of the Affordable Care Act, addressing persistent racial and ethnic disparities in the US with emphasis on access, quality, and outcomes is of paramount importance.² A prospective qualitative analysis of physician and stakeholder understanding and expectations of discharge destinations is warranted.

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Dr. Meagher and Ms. Doorey had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

TABLE 4. Adjusted odds of discharge to a higher level of rehabilitation in patients with TBI who were Medicare beneficiaries ≥ 65 years old

Factor	OR	95% CI	p Value
NHW	1.0	Reference	—
Hispanic	0.786	0.714–0.864	<0.001
Black	0.872	0.811–0.937	<0.001
LOS	1.091	1.078–1.105	<0.001
ICU days	1.052	1.033–1.071	<0.001
Vent days	0.952	0.936–0.969	<0.001

References

1. Alban RF, Berry C, Ley E, Mirocha J, Margulies DR, Tillou A, et al: Does health care insurance affect outcomes after traumatic brain injury? Analysis of the National Trauma Data Bank. **Am Surg** 76:1108–1111, 2010
2. Betancourt JR, King RK: Unequal treatment: the Institute of Medicine report and its public health implications. **Public Health Rep** 118:287–292, 2003
3. Chan L, Doctor J, Temkin N, MacLehose RF, Esselman P, Bell K, et al: Discharge disposition from acute care after traumatic brain injury: the effect of insurance type. **Arch Phys Med Rehabil** 82:1151–1154, 2001
4. Cifu DX, Kreutzer JS, Kolakowsky-Hayner SA, Marwitz JH, Englander J: The relationship between therapy intensity and rehabilitative outcomes after traumatic brain injury: a multicenter analysis. **Arch Phys Med Rehabil** 84:1441–1448, 2003
5. Coronado VG, Xu L, Basavaraju SV, McGuire LC, Wald MM, Faul MD, et al: Surveillance for traumatic brain injury-related deaths—United States, 1997–2007. **MMWR Surveill Summ** 60:1–32, 2011
6. Dikmen SS, Machamer JE, Powell JM, Temkin NR: Outcome 3 to 5 years after moderate to severe traumatic brain injury. **Arch Phys Med Rehabil** 84:1449–1457, 2003
7. Englum BR, Villegas C, Bolorunduro O, Haut ER, Cornwell EE III, Efron DT, et al: Racial, ethnic, and insurance status disparities in use of posthospitalization care after trauma. **J Am Coll Surg** 213:699–708, 2011
8. Ennis SR, Rios-Vargas M, Albert NG: **The Hispanic population: 2010. 2010 Census Briefs.** (<http://www.census.gov/prod/cen2010/briefs/c2010br-04.pdf>) [Accessed October 16, 2014]
9. Gary KW, Arango-Lasprilla JC, Stevens LF: Do racial/ethnic differences exist in post-injury outcomes after TBI? A comprehensive review of the literature. **Brain Inj** 23:775–789, 2009
10. Greenwood RJ, Strens LH, Watkin J, Losseff N, Brown MM: A study of acute rehabilitation after head injury. **Br J Neurosurg** 18:462–466, 2004
11. Haider AH, Weygandt PL, Bentley JM, Monn MF, Rehman KA, Zarzaur BL, et al: Disparities in trauma care and outcomes in the United States: a systematic review and meta-analysis. **J Trauma Acute Care Surg** 74:1195–1205, 2013
12. Lefebvre H, Pelchat D, Swaine B, Gélinas I, Levert MJ: The experiences of individuals with a traumatic brain injury, families, physicians and health professionals regarding care provided throughout the continuum. **Brain Inj** 19:585–597, 2005
13. Nelson A: Unequal treatment: confronting racial and ethnic disparities in health care. **J Natl Med Assoc** 94:666–668, 2002
14. Nelson AR: Unequal treatment: report of the Institute of Medicine on racial and ethnic disparities in healthcare. **Ann Thorac Surg** 76:S1377–S1381, 2003
15. Nichol AD, Higgins AM, Gabbe BJ, Murray LJ, Cooper DJ, Cameron PA: Measuring functional and quality of life outcomes following major head injury: common scales and checklists. **Injury** 42:281–287, 2011
16. Powell J, Heslin J, Greenwood R: Community based rehabilitation after severe traumatic brain injury: a randomised controlled trial. **J Neurol Neurosurg Psychiatry** 72:193–202, 2002
17. Rastogi S, Johnson TD, Hoeffel EM, Drewery MP Jr: **The Black population: 2010. 2010 Census Briefs.** (<http://www.census.gov/prod/cen2010/briefs/c2010br-06.pdf>) [Accessed October 14, 2014]
18. Shafi S, de la Plata CM, Diaz-Arrastia R, Bransky A, Frankel H, Elliott AC, et al: Ethnic disparities exist in trauma care. **J Trauma** 63:1138–1142, 2007
19. Shafi S, Marquez de la Plata C, Diaz-Arrastia R, Shipman K, Carlile M, Frankel H, et al: Racial disparities in long-term functional outcome after traumatic brain injury. **J Trauma** 63:1263–1270, 2007
20. Staudenmayer KL, Diaz-Arrastia R, de Oliveira A, Gentilello LM, Shafi S: Ethnic disparities in long-term functional outcomes after traumatic brain injury. **J Trauma** 63:1364–1369, 2007
21. Whitlock JA Jr, Hamilton BB: Functional outcome after rehabilitation for severe traumatic brain injury. **Arch Phys Med Rehabil** 76:1103–1112, 1995

Author Contributions

Conception and design: all authors. Acquisition of data: all authors. Analysis and interpretation of data: Meagher, Beadles. Drafting the article: Meagher. Critically revising the article: Charles. Reviewed submitted version of manuscript: Charles, Meagher, Beadles. Statistical analysis: Meagher, Doorey. Study supervision: Charles.

Supplemental Information

Previous Presentation

This study was presented as a poster at the 72nd Annual Meeting of the American Association for the Surgery of Trauma and Clinical Congress of Acute Care Surgery.

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