Race and Insurance Disparities in Discharge to Rehabilitation for Patients with Traumatic Brain Injury

Anthony O. Asemota,^{1,2} Benjamin P. George,^{2,3} Carolyn J. Cumpsty-Fowler,^{4–6}
Adil H. Haider,^{2,6,7} and Eric B. Schneider^{2,7}

Abstract

Post-acute inpatient rehabilitation services are associated with improved functional outcomes among persons with traumatic brain injury (TBI). We sought to investigate racial and insurance-based disparities in access to rehabilitation. Data from the Nationwide Inpatient Sample from 2005–2010 were analyzed using standard descriptive methods and multivariable logistic regression to assess race- and insurance-based differences in access to inpatient rehabilitation after TBI, controlling for patient- and hospital-level variables. Patients with moderate to severe TBI aged 18–64 years with complete data on race and insurance status discharged alive from inpatient care were eligible for study. Among 307,675 TBI survivors meeting study criteria and potentially eligible for discharge to rehabilitation, 66% were white, 12% black, 15% Hispanic, 2% Asian, and 5% other ethnic minorities. Most whites (70%), Asians (70%), blacks (59%), and many Hispanics (49%) had insurance. Compared with insured whites, insured blacks had reduced odds of discharge to rehabilitation (odds ratio [OR] 0.84; 95% confidence interval [CI] 0.75–0.95). Also, insured Hispanics (OR 0.52; 95% CI 0.44–0.60) and insured Asians (OR 0.54; 95% CI 0.39–0.73) were less likely to be discharged to rehabilitation than insured whites. Compared with insured whites, uninsured whites (OR 0.57; 95% CI 0.51–0.63), uninsured blacks (OR 0.33; 95% CI 0.26–0.42), uninsured Hispanics (OR 0.27; 95% CI 0.22–0.33), and uninsured Asians (OR 0.40; 95% CI 0.22–0.73) were less likely to be discharged to rehabilitation. Race and insurance are strong predictors of discharge to rehabilitation among adult TBI survivors in the United States. Efforts are needed to understand and eliminate disparities in access to rehabilitation after TBI.

Key words: disparities; epidemiology; rehabilitation; traumatic brain injury

Introduction

TRAUMATIC BRAIN INJURY (TBI) is a leading cause of morbidity and mortality in the United States.¹ More than 1.5 million persons sustain TBI annually resulting in 50,000 deaths, leaving an estimated 90,000 persons with significant disability and/or physical impairment.^{1,2} Others experience problems ranging from short-term memory and neurocognitive deficits to long-term physical impairment, and psychological, emotional, and social problems.^{3,4} These effects can be especially profound among patients experiencing moderate to severe TBI.^{4–6} For TBI survivors having serious physical impairments and disabilities, post-discharge care may constitute a huge financial and emotional burden for their families and caregivers.^{5–7}

According to the National Institutes of Health, rehabilitation in the post-acute injury period is associated with improved functional

outcomes for TBI survivors,^{8–10} and may lead to enhanced quality of life.^{11,12} Underlying racial disparities, poverty, and low socioeconomic status are factors that complicate access to and quality of care after trauma.^{13–17} This study examines the influence of race and ethnicity, as well as insurance status, on access to post-discharge inpatient rehabilitation and other post-acute care among patients with TBI.

Methods

Study design

A retrospective 6-year (2005–2010) study was performed using hospital discharge records from the Nationwide Inpatient Sample (NIS) maintained by the Agency for Healthcare Research and Quality.¹⁸ The NIS is the largest all-payer sample of inpatient discharge data. In 2010, the NIS sampling frame represented 96%

¹Department of Neurology/Neurosurgery, Johns Hopkins School of Medicine, Baltimore, Maryland.

²Center for Surgical Trials and Outcomes Research (CSTOR), Johns Hopkins University, Baltimore, Maryland.

³University of Rochester, School of Medicine and Dentistry, Rochester, New York.

⁴Department of Community-Public Health, Johns Hopkins University School of Nursing, Baltimore, Maryland.

⁵Center for Injury Research and Policy, Johns Hopkins University, Baltimore, Maryland.

⁶Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland.

⁷Department of Surgery, Division of Acute Care Surgery and Adult Trauma, Johns Hopkins School of Medicine, Baltimore, Maryland.

of all U.S. hospital discharges, collecting information from 1051 hospitals in 45 states.¹⁸ TBI was identified using International Classification of Diseases-9-CM diagnostic codes (800.0–801.9, 803.0–804.9, and 850.0–854.1) as classified by the Centers for Disease Control (CDC).²

Study participants

Adult TBI admissions from 2005–2010 aged 18–64 years were analyzed in five age groups (18–24 years, 25–34 years, 35–44 years, 45–54 years, and 55–64 years). The racial and ethnic variables in the NIS¹⁸ were grouped as white, black, Hispanic, Asian or Pacific Islander, and other, which included Native Americans and other ethnic minorities. Participants were grouped into three categories according to the primary insurance payer: “government insured” (including Medicare and Medicaid), “privately insured” (including Health Maintenance Organization, Preferred Provider Organization, commercial payers), and “uninsured” (self-pay, no charge, and other undefined category). Injury mechanisms resulting in TBI were identified using the injury E-codes and categorized based on the CDC recommended matrix.¹⁹

TBI severity was defined using the Abbreviated Injury Severity (AIS) score.²⁰ This system scores injuries in different anatomical regions based on severity with the least severe receiving a score of 1 and the most severe receiving a score of 6.²¹ For this study, we examined persons with substantial head trauma (Head AIS ≥ 3) and classified those scored as 3 as moderate and those scored as 4 or 5 as severe. Persons with AIS scores of 6 were excluded from the study because these injuries are deemed unsurvivable.²²

Discharge outcomes

The main outcome of interest was discharge to inpatient rehabilitation directly from the index hospital. Post-discharge disposition obtained from the NIS using the DISPuniform variable for all years (2005–2010) was directly matched with the separate variables and more specific variables for DISPUB92 (2005–2006) and DISPUB04 (2007–2010).¹⁸ A new categorical variable representing discharge dispositions was constructed by combining information from DISPuniform and the more specific variables (DISPUB92 and DISPUB04) in their respective years of availability to maximize the availability of discharge disposition data. This new variable was composed of seven potential discharges as follows: home without professional support, home care with professional support, skilled nursing facilities, rehabilitation, short-term care, intermediate/long-term care, and other discharge disposition (see online supplementary Table 1 at ftp.liebertpub.com).

Exclusion criteria

Pediatric (<18 years) and geriatric patients (>65 years) were excluded from the study because of known differences in insurance type (e.g., Medicare coverage among older adults) and differing response to trauma in both the geriatric and pediatric groups.^{17,23} Patients with polytrauma having injuries with AIS score ≥ 3 in body regions apart from the head were excluded from the study to eliminate the possibility that discharge destination was affected by injuries that did not involve the head. Also, persons with missing race, discharge outcomes, E-code, insurance payer status, or hospital level variables (e.g., hospital region, teaching status) were excluded from the study.

Statistical analysis

Univariate and multivariate logistic regression analyses were used in this study. Patients who died in the hospital were not at risk for discharge to rehabilitation and were therefore excluded from the discharge destination analysis. Also, persons with missing

discharge disposition were excluded from the regression analysis. Separate logistic regression analysis was performed for each discharge disposition comparing persons of each non-white racial/ethnic group with whites. Variables included in the regression model were based on *a priori* assessment of clinical relevance and on the results of previous studies examining patient and hospital level factors associated with discharge to rehabilitation and other discharge destinations.²⁴ We also explored the interaction between race and insurance payer status and its effect on discharge disposition. Multinomial logistic regression was used to determine relative risk ratios (RRR) of discharge destinations with “discharge to home without support” as the base-outcome. Chi-square tests were used in determining statistical significance for all categorical variables. Subset analysis of patients with isolated TBI, defined as having head AIS ≥ 3 and no AIS score above zero for any other body region, was also performed.

To validate our findings a separate analysis was conducted where cases were matched on patient and hospital level variables using the coarsened exact matching (CEM) and regressed against the outcome.²⁵ As part of our validation study, we conducted a propensity score analysis matching on all variables. All analyses were performed using Stata version 12.0 (Stata, College Station, TX).

Results

A total of 461,123 TBI admissions identified from 2005–2010 met the age (18–64 years) and head injury severity (AIS3–5) criteria. Of this number, 98,528 (21%) were excluded because of missing race variables. Of the remaining 362,595 cases, 32,928 (9%) cases were excluded from the study because of missing demographic and hospital variables. Proportionally, those excluded did not significantly differ by race (whites 65%, black 13%, Hispanic 15%, Asian/Pacific Islander 2%, others 5%) and insurance status (government insured 24%, private insured 40%, uninsured 31%) of the entire population. Of the remaining 329,667 cases, 21,992 (6.67%) resulted in death before discharge leaving 307,675 TBI survivors potentially eligible for discharge to rehabilitation. In the entire group of patients studied, 233,595 (71.8%) were male, 215,085 (65.2%) were white, 42,493 (12.9%) were black, 48,296 (14.6%) Hispanic, 7655 (2.3%) Asian/Pacific Islander, and 16,138 (4.8%) were classified as other (Table 1).

The mean age of study participants was 41.5 years. Overall, 66% of patients had health insurance coverage (41.6% with private insurance and 23.9% covered by government policies), and 34% were uninsured. White and Asian/Pacific Islander patients were most likely to be insured (approximately 70% in each group) with most white (48.7%) patients carrying private insurance. Approximately 60% of blacks were also insured, and the most common coverage (34.5%) was government-provided. More than half of all Hispanics (50.7%) were without any form of health insurance.

Moderate TBI (AIS 3) accounted for approximately 62.6% of the cases analyzed, while severe TBI, classified as AIS 4 and AIS 5, represented 34.6% and 2.7%, respectively, of all eligible admissions. Falls represented the highest proportion of TBI admissions (35.8%) and was the leading injury mechanism among whites (39.3%). This was followed by motor vehicle occupant injuries (17.5%), highest among Asian/Pacific Islanders (19.6%). Firearm injuries accounted for 2.2% of TBI among whites, 7.9% among blacks, and 3.8% among Hispanics ($p < 0.001$). Injury severity was most strongly associated with Asian/Pacific Islander background and black races with 42.1% and 40.9% of admissions, respectively, occurring for severe TBI (AIS 4–5) in these two groups.

TABLE 1. PATIENT AND INJURY CHARACTERISTICS FOR ADULTS (18–64 YEARS) WITH MODERATE TO SEVERE TRAUMATIC BRAIN INJURY

<i>Patient characteristics</i> (N = 329,667)	<i>Whites</i> (n = 215,085)	<i>Blacks</i> (n = 42,493)	<i>Hispanics</i> (n = 48,296)	<i>Asian and Pacific Islander</i> (n = 7,655)	<i>Others</i> (n = 16,138)	<i>p value</i>
Males	154,459 (71.81)	34,401 (80.96)	40,658 (84.19)	5054 (66.02)	12,917 (80.04)	<0.001
Age group, no. (%)						
18–24 years	34,187 (15.89)	7543 (17.75)	10,047 (20.80)	1067 (13.94)	3013 (18.67)	
25–34 years	35,187 (16.36)	7999 (18.82)	13,435 (27.82)	1270 (16.59)	3686 (22.84)	
35–44 years	36,200 (16.83)	7725 (18.18)	8801 (18.22)	1283 (16.76)	2899 (17.96)	<0.001
45–54 years	55,110 (25.62)	11,096 (26.11)	9299 (19.25)	1657 (21.65)	3579 (22.18)	
55–64 years	54,401 (25.29)	8130 (19.13)	6713 (13.90)	2377 (31.05)	2961 (18.35)	
Insurance status, no. (%)						
Private	105,060 (48.85)	10,882 (25.61)	12,132 (25.12)	3700 (48.33)	5437 (33.69)	
Government	46,369 (21.56)	14,654 (34.49)	11,660 (24.14)	1739 (22.72)	4226 (26.19)	<0.001
Uninsured	63,656 (29.60)	16,957 (39.91)	24,504 (50.74)	2215 (28.94)	6475 (40.12)	
AIS score, no. (%)						
AIS score 3	135,686 (63.08)	25,080 (59.02)	31,154 (64.51)	4430 (57.87)	10,178 (63.07)	
AIS score 4	73,950 (34.38)	15,970 (37.58)	15,821 (32.76)	3049 (39.83)	5494 (34.04)	<0.001
AIS score 5	5450 (2.53)	1443 (3.40)	1321 (2.74)	176 (2.30)	465 (2.88)	
Injury mechanism, No. (%)						
MVA occupant	37,716 (17.54)	6394 (15.05)	8590 (17.79)	1497 (19.56)	2507 (15.53)	
Motorcycle	13,759 (6.40)	1140 (2.68)	1632 (3.38)	153 (2.00)	446 (2.76)	
Bike	8569 (3.98)	956 (2.25)	1740 (3.60)	369 (4.82)	509 (3.15)	
Pedestrian	6339 (2.95)	2016 (4.74)	2577 (5.34)	532 (6.95)	740 (4.59)	
Other transport	11,358 (5.28)	385 (0.91)	1216 (2.52)	88 (1.15)	404 (2.50)	<0.001
Falls	84,557 (39.31)	12,144 (28.58)	14,692 (30.42)	3257 (42.55)	5754 (35.66)	
Firearms	4626 (2.15)	3354 (7.89)	1849 (3.83)	102 (1.33)	422 (2.61)	
Struck/cut/pierced	26,776 (12.45)	9385 (22.09)	9571 (19.82)	919 (12.01)	3052 (18.91)	
Other injury	21,385 (9.94)	6719 (15.81)	6430 (13.31)	739 (9.65)	2305 (14.28)	
Injury intent, no. (%)						
Unintentional	194,623 (90.49)	32,198 (75.77)	41,760 (86.47)	7204 (94.11)	13,353 (82.74)	
Intentional	18,725 (8.71)	9755 (22.96)	6261 (12.96)	420 (5.49)	2646 (16.40)	<0.001
Missing/undetermined	1737 (0.81)	539 (1.27)	274 (0.57)	31 (0.40)	139 (0.86)	
Isolated TBI, no. (%)	89,352 (41.54)	19,394 (45.64)	18,672 (38.66)	3687 (48.16)	6938 (42.99)	<0.001
Age, mean (SD), years						
Males	41.50 (14.08)	40.33 (13.61)	36.79 (13.05)	42.79 (14.30)	38.59 (13.49)	<0.001
Females	45.50 (13.71)	42.60 (13.84)	41.66 (14.40)	45.71 ^a (13.78)	43.81 (14.13)	<0.001

AIS, Abbreviated Injury Severity; MVA, motor vehicle accident; TBI, traumatic brain injury.

^aNot significantly different from that of whites at $p < 0.05$ confidence level.

Overall, most TBI survivors were discharged home (68.3%), followed by discharge to inpatient rehabilitation (6.8%), home with professional support (4.2%), skilled nursing care (3.2%), short-term care (2.8%), intermediate/long-term care (1.2%). Other discharge destinations, including discharge against medical advice and destination unknown, accounted for 4.5% of all discharges. Discharge to rehabilitation was proportionally highest among whites (7.7%) and lowest among Hispanics (3.4%). Race-based disparities were also evident in terms of discharge to other post-acute facilities. Geographically, the largest proportion of TBI admissions (40%) occurred in the South (Table 2).

Multiple logistic regression analysis examining the entire discharge group (Fig. 1) demonstrated that black patients were 17% less likely to be discharged to rehabilitation (odds ratio [OR] 0.83; 95% confidence interval [CI] 0.74–0.92), compared with white patients. Also, Hispanic patients were 48% less likely (OR 0.52; 95% CI 0.43–0.75) and Asian/Pacific Islanders were 43% less likely (OR 0.57; 95% CI 0.43–0.75) to be discharged to inpatient rehabilitation, compared with white patients.

Blacks (OR 0.60; 95% CI 0.46–0.77), Hispanics (OR 0.60; 95% CI 0.46–0.78), and Asian/Pacific Islanders (OR 0.38; 95% CI 0.18–0.82) demonstrated reduced odds of discharge to intermediate/long-term care facilities compared with whites. Hispanics (OR 0.72; 95% CI 0.58–0.91), Asian/Pacific Islanders (OR 0.51; 95% CI 0.33–0.79), and Native Americans/other ethnic minorities (OR 0.71; 95% CI 0.52–0.97) all demonstrated reduced odds of discharge to skilled nursing care, compared with white patients. Hispanic patients (OR 1.57; 95% CI 1.44–1.71) and Asian/Pacific Islanders (OR 1.59; 95% CI 1.31–1.93) demonstrated substantially higher odds of being discharged to home without support, compared with whites.

Overall, insured persons were more likely to be discharged to rehabilitation than uninsured persons (Fig. 2). Separate analysis of the subgroup of insured persons demonstrated that, compared with insured white patients, insured blacks had reduced odds of discharge to rehabilitation (OR 0.84; 95% CI 0.75–0.95), as did insured Hispanics (OR 0.52; 95% CI 0.44–0.60) and insured Asians (OR 0.54; 95% CI 0.39–0.73). In further subsets analysis

TABLE 2. HOSPITAL CHARACTERISTICS AND DISCHARGE DISPOSITIONS FOR ADULTS (18–64 YEARS) WITH MODERATE TO SEVERE TRAUMATIC BRAIN INJURY

<i>Hospital characteristics</i> (N = 329,667)	<i>Whites</i> (n = 215,085)	<i>Blacks</i> (n = 42,493)	<i>Hispanics</i> (n = 48,296)	<i>Asian and Pacific Islander</i> (n = 7655)	<i>Others</i> (n = 16,138)	<i>p value</i>
Hospital location and teaching status						
Rural non-teaching	9003 (4.19)	570 (1.34)	417 (0.86)	129 (1.69)	424 (2.63)	<0.001
Urban non-teaching	62,278 (28.96)	7167 (16.87)	13,379 (27.70)	1941 (25.36)	3272 (20.28)	
Urban teaching	143,804 (66.86)	34,756 (81.79)	34,499 (71.43)	5584 (72.95)	12,442 (77.10)	
Hospital bed size						
Small	8486 (3.95)	1497 (3.52)	1757 (3.64)	430 (5.62)	562 (3.48)	<0.001
Medium	44,235 (20.57)	8672 (20.41)	7267 (15.05)	1020 (13.32)	2876 (17.82)	
Large	162,364 (75.49)	32,323 (76.07)	39,273 (81.32)	6204 (81.05)	12,701 (78.70)	
Hospital region						
Northeast	51,136 (23.77)	11,696 (27.52)	9066 (18.77)	2208 (28.84)	6065 (37.58)	<0.001
Midwest	32,434 (15.08)	5638 (13.27)	1722 (3.57)	395 (5.16)	1441 (8.93)	
South	86,952 (40.43)	20,623 (48.53)	18,288 (37.87)	1424 (18.60)	4777 (29.60)	
West	44,563 (20.72)	4537 (10.68)	19,220 (39.80)	3627 (47.38)	3856 (23.89)	
Volume of hospital TBI discharges						
< 200	57,629 (26.79)	8744 (20.58)	10,716 (22.19)	2208 (28.84)	3714 (23.01)	<0.001
200 – 435	50,949 (23.69)	12,522 (29.47)	12,090 (25.03)	2438 (31.85)	5003 (31.00)	
437 – 694	50,946 (23.69)	11,590 (27.28)	13,182 (27.29)	1749 (22.85)	3780 (23.42)	
≥ 695	55,561 (25.83)	9638 (22.68)	12,308 (25.48)	1259 (16.45)	3641 (22.56)	
Ventilator use						
Unspecified duration/none	169,645 (78.87)	32,459 (76.39)	36,844 (76.29)	6173 (80.64)	12,505 (77.49)	<0.001
Less than 96 hours	28,457 (13.23)	6077 (14.30)	6873 (14.23)	836 (10.92)	2265 (14.04)	
More than 96 hours	16,983 (7.90)	3958 (9.31)	4579 (9.48)	645 (8.43)	1368 (8.48)	
Length of stay, mean (SD), days						
Males	6.82 (11.62)	7.98 ^a (14.43)	7.58 ^a (13.84)	7.39 (11.40)	7.18 (14.30)	<0.001
Females	6.05 (9.01)	7.48 ^a (10.95)	6.70 ^a (9.62)	6.27 (8.75)	6.96 (11.58)	
Mean unadjusted total charges (USD)						
Males	61,627 (97,568.02)	65,933.86 ^a (108,186.60)	78,115.03 ^a (123,708.40)	81,228.10 ^a (133,976.40)	62,741.42 (111,378.60)	<0.001
Females	52,860.75 (79,234.14)	64,966.79 ^a (100,196.60)	70,034.11 ^a (100,840.10)	68,953.33 ^a (101,008.60)	65,768.83 ^a (110,835.80)	
Discharge disposition, No. (%) (N = 329,667)						
Home without support	144,664 (67.26)	27,750 (65.30)	35,833 (74.19)	5386 (70.36)	11,482 (71.15)	<0.001
Home with professional support	9548 (4.44)	2008 (4.73)	1478 (3.06)	372 (4.86)	455 (2.82)	
Skilled nursing care	7260 (3.38)	1751 (4.12)	853 (1.77)	132 (1.72)	381 (2.36)	
Rehabilitation	16,610 (7.72)	2712 (6.38)	1629 (3.37)	303 (3.96)	1181 (7.32)	
Intermediate/long-term care	2957 (1.37)	402 (0.95)	347 (0.72)	36 (0.47)	132 (0.82)	
Short-term care	5876 (2.73)	1164 (2.74)	1328 (2.75)	247 (3.23)	498 (3.09)	
Discharge against medical advice/other	9836 (4.57)	2482 (5.84)	1824 (3.78)	237 (3.10)	666 (4.13)	
Missing	4421 (2.06)	839 (1.97)	1916 (3.97)	462 (6.04)	219 (1.36)	
Died	13913 (6.47)	3386 (7.97)	3089 (6.40)	480 (6.27)	1124 (6.96)	

TBI, traumatic brain injury; USD, United States dollars.

^aDiffered significantly from whites at $p < 0.05$ confidence level.

FIG. 1. Odds ratios of discharge dispositions by race.

ref, reference group; *, significantly different from whites at $p < 0.05$. Error bars represent 95% confidence intervals.

examining insurance type, government insured blacks had similar odds of discharge to rehabilitation (OR 0.99; 95% CI 0.85–1.19) compared to government insured whites. Privately insured blacks, however, were 21% less likely (OR 0.79; 95% CI 0.65–0.94) to be discharged to rehabilitation compared with privately insured whites. Also, privately insured Hispanics were 44% less likely (OR 0.56; 95% CI 0.45–0.79) and private insured Asians 46% less likely (OR 0.54; 95% CI 0.37–0.79) to be discharged to inpatient rehabilitation compared with white patients covered by private health insurance. Further exploration of the interaction between race and insurance payer status revealed that government insured whites, blacks, Hispanics, and Asian/Pacific Islanders, as well as privately insured blacks, Hispanics, and Asians were all less likely to be discharged to inpatient rehabilitation, compared with privately insured whites.

Multinomial logistic regression with discharge disposition as a categorical polytomous outcome showed that blacks (RRR 0.81; 95% CI 0.70–0.94), Hispanics (RRR 0.45; 95% CI 0.37–0.54), and Asians (RRR 0.47; 95% CI 0.33–0.66) all had lower RRR of discharge to rehabilitation *vs* being discharged home without support compared with whites. Again, compared with whites, blacks had

similar adjusted RRR of discharge to home with professional support (RRR 1.02; 95% CI 0.85–1.23) and skilled nursing care (RRR 0.94; 95% CI 0.80–1.11) *vs* discharge to home without professional support (Table 3).

Persons with the most severe head injury (AIS 5) showed a higher likelihood of discharge to rehabilitation (RRR 1.97; 95% CI 1.42–2.75), skilled nursing care (RRR 2.50; 95% CI 1.60–3.92), and intermediate/long-term care (RRR 6.07 95% CI 3.82–9.63) *vs* discharge to home without support, compared with persons with moderate head trauma (AIS 3). Reduced RRR of discharge to rehabilitation *vs* home without support were evident in the South (RRR 0.61; 95% CI 0.56–0.67) and West (RRR 0.43; 95% CI 0.38–0.48) compared with the Northeast.

Including an injury intent variable in the model did not affect the above findings. Also, restricting the analysis to the subset of patients with isolated TBI did not significantly alter the findings. The separate validation study using conditional logistic regression to examine data matched using the CEM technique also produced results similar to the original analysis. Finally, the results produced by the validation study performed using propensity score analysis were similar to those obtained using the original parsimonious

FIG. 2. Odds ratios of rehabilitation by race and insurance payer status. ref, reference group; a, significantly different from whites at $p < 0.005$. The error bars represent 95% confidence intervals.

logistic regression models (see supplementary Table 2 online at [ftp.liebertpub.com](http://liebertpub.com)).

Discussion

Evidence for the existence of racial disparities in access to post-acute inpatient rehabilitation for persons with moderate to severe TBI is compelling. Blacks, Hispanics, Asian/Pacific Islanders, and other ethnic minorities were less likely to be discharged to rehabilitation compared with equivalently injured whites. White patients were more likely to be discharged from the index hospital to some form of continuing care, including inpatient rehabilitation, than patients of other race (Fig. 1,2).

Our findings are consistent with previously published studies that have reported racial and ethnic disparities in access to rehabilitation for TBI survivors.^{14,17,26} The observed disparities in discharge from acute care directly to inpatient rehabilitation were also influenced by health insurance status. Generally, regardless of race, uninsured patients were half as likely as insured patients to be discharged to rehabilitation. Similar findings were evident for other forms of post-acute care in that uninsured TBI survivors were also less likely to be discharged to any other form of post-acute care—including skilled nursing care, short-term care, intermediate/long-term care, or even home with professional support, compared with insured patients. Again, whether insured or uninsured, Hispanics and Asian/Pacific Islanders were less likely to be discharged to rehabilitation or other continued care facility compared with whites.

Previous studies have demonstrated the existence of race and insurance-status based disparities in the long-term functional outcomes of survivors of TBI, with minority groups often experiencing worse long-term deficits.^{15,27–29} Functional outcomes for many persons recovering from moderate to severe TBI can be improved with intensive physical, occupational, and cognitive rehabilitation.³⁰ Also participation in comprehensive neuro-psychological rehabilitation after discharge from acute care has been associated with significant improvement in neurocognitive and social skills.^{31,32}

The observed disparities in access to inpatient rehabilitation and other post-discharge professional care suggest the possibility of worse functional outcomes and reduced long-term quality of life among non-white TBI victims.^{33,34} Potential consequences of inadequate rehabilitation include unemployment and job instability.^{35,36} Previous research demonstrates that black TBI victims and TBI victims who are members of other minority groups are less likely to return to pre-injury levels of productivity compared with similarly injured white TBI persons.³⁷

Our findings suggest that the racial disparities reported in post-TBI outcomes, including employment and productivity, might be driven at least in part by underlying racial disparities in access to appropriate rehabilitation services and continued post-acute care.^{37,38} Further, the observed geographical differences in discharge disposition by region might be related to uneven representation of different racial and ethnic groups across different regions of the United States and with geographical challenges associated with getting to post-acute care.³⁹

TABLE 3. MULTINOMIAL LOGISTIC REGRESSION MODEL COMPARING DISCHARGE DISPOSITION TO DISCHARGE HOME WITHOUT SUPPORT AS THE BASE OUTCOME

<i>Variables</i> <i>N = 299,818</i>	<i>Home professional support</i>	<i>Inpatient rehabilitation</i>	<i>Skilled nursing care</i>	<i>Short term care</i>	<i>Intermediate/Long term care</i>	<i>Other destination</i>
	<i>RRR (95% CI)</i>	<i>RRR (95% CI)</i>	<i>RRR (95% CI)</i>	<i>RRR (95% CI)</i>	<i>RRR (5% CI)</i>	<i>RRR (95% CI)</i>
Home without support (Base outcome)	1.00	1.00	1.00	1.00	1.00	1.00
Race						
Whites (ref)	1.00	1.00	1.00	1.00	1.00	1.00
Blacks	1.02 (0.91–1.16)	0.82 (0.73–0.92)	0.94 (0.82–1.09)	1.26 (1.08–1.48)	0.58 (0.45–0.75)	0.97 (0.87–1.09)
Hispanics	0.77 (0.67–0.88)	0.45 (0.40–0.52)	0.57 (0.48–0.69)	0.93 (0.80–1.07)	0.48 (0.36–0.63)	0.66 (0.58–0.75)
Asians and Pacific Islander	0.90 (0.70–1.16)	0.47 (0.35–0.63)	0.41 (0.27–0.61)	0.86 (0.63–1.16)	0.30 (0.14–0.65)	0.57 (0.42–0.78)
Others	0.66 (0.53–0.82)	0.98 (0.83–1.16)	0.65 (0.50–0.85)	1.14 (0.92–1.42)	0.61 (0.41–0.92)	0.66 (0.55–0.80)
Insurance payer						
Private (ref)	1.00	1.00	1.00	1.00	1.00	1.00
Government	1.44 (1.31–1.59)	1.00 (0.92–1.10)	3.22 (2.87–3.61)	1.01 (0.90–1.14)	2.04 (1.72–2.42)	2.13 (1.93–2.36)
Uninsured	0.62 (0.55–0.69)	0.43 (0.39–0.47)	0.60 (0.52–0.70)	0.53 (0.47–0.60)	0.45 (0.36–0.57)	1.41 (1.28–1.56)
Age group (years)						
18–24 years (ref)	1.00	1.00	1.00	1.00	1.00	1.00
25–34 years	1.11 (0.93–1.32)	0.91 (0.80–1.03)	1.39 (1.05–1.83)	1.02 (0.86–1.20)	1.66 (1.12–2.45)	1.31 (1.14–1.51)
35–44 years	1.36 (1.15–1.61)	1.08 (0.95–1.23)	2.19 (1.68–2.85)	1.20 (1.01–1.43)	2.75 (1.89–4.00)	1.8 (1.57–2.06)
45–54 years	1.83 (1.57–2.14)	1.29 (1.15–1.45)	3.64 (2.86–4.63)	1.37 (1.17–1.61)	4.04 (2.84–5.75)	1.81 (1.58–2.06)
55–64 years	2.93 (2.52–3.41)	1.80 (1.60–2.02)	8.17 (6.44–10.36)	1.66 (1.41–1.96)	7.26 (5.10–10.32)	1.62 (1.40–1.88)
Gender						
Males (ref)	1.00	1.00	1.00	1.00	1.00	1.00
Females	1.43 (1.31–1.56)	1.14 (1.06–1.24)	1.15 (1.03–1.29)	1.08 (0.96–1.20)	1.03 (0.87–1.22)	0.77 (0.70–0.85)
AIS score						
AIS score 3 (ref)	1.00	1.00	1.00	1.00	1.00	1.00
AIS score 4	1.10 (0.99–1.22)	1.08 (0.98–1.18)	1.17 (1.03–1.33)	0.95 (0.83–1.08)	1.08 (0.89–1.31)	1.11 (1.00–1.23)
AIS score 5	0.89 (0.50–1.60)	1.97 (1.42–2.75)	2.50 (1.60–3.92)	2.82 (1.93–4.12)	6.07 (3.82–9.63)	2.51 (1.71–3.67)
Hospital region						
Northeast (ref)	1.00	1.00	1.00	1.00	1.00	1.00
Midwest	0.78 (0.68–0.90)	0.98 (0.87–1.09)	0.69 (0.59–0.81)	1.35 (1.15–1.60)	1.99 (1.48–2.67)	0.59 (0.52–0.67)
South	0.85 (0.77–0.94)	0.61 (0.56–0.67)	0.66 (0.59–0.75)	0.85 (0.73–0.99)	2.61 (2.04–3.33)	0.53 (0.48–0.58)
West	0.58 (0.51–0.66)	0.43 (0.38–0.48)	0.30 (0.25–0.36)	1.99 (1.72–2.30)	1.74 (1.32–2.30)	0.45 (0.40–0.51)

CI, confidence interval; RRR, relative risk ratio; ref, reference group; AIS, Abbreviated Injury Severity; Other destination includes discharge against medical advice and destination unknown.

Increasing age and sex appeared to be positively associated with discharge to rehabilitation and other post-acute care facility for moderate and severe TBI survivors. When controlling for TBI severity, females were more likely to be discharged to rehabilitation compared with males. Although previous studies have reported racial and ethnic disparities but no sex disparities in the emergency department care of patients with mild TBI, some researchers have called attention to the observation that women may in fact be at higher risk for differential access in trauma care and poorer outcomes after major trauma.^{40,41}

Some limitations affecting our study include the retrospective design, possible misclassification of race in patient records, and misreporting for persons of mixed race. Also, coding for the race variable in the NIS varies from self-reporting in some hospitals to physician estimation in others.¹⁴ Additional factors that might bias our findings include the following: **race** identification was not reported for 21% of the total population, injury severity distributions differ by race, and information on emergency department treatment and disposition (other than admission to inpatient status) was not available. It was also not possible to tell

from the data if patient, family, or cultural preferences affected the likelihood of transfer to rehabilitation and other post-acute care facilities.¹⁴ Despite these limitations, our study strengths lie in that the NIS provides a rich source of demographic and socioeconomic data and is the only nationwide database that provides information for all insurance types, including patients covered by Medicaid, Medicare, private insurance, and uninsured persons.¹⁸

Over the past several decades, researchers have proposed various recommendations to attempt to reduce racial and socioeconomic disparities in health care access, some of which might be applicable to the population with TBI.^{42–45} Interventions targeting communities as a strategy for improving health and eliminating barriers to access should be considered.^{44–46} Also, it may be possible to close the disparities gap through strategies to prevent TBI focused on the needs of specific racial and age groups.⁴⁶ It is possible that communication barriers may hinder the physician-patient relationship limiting access to post-acute care rehabilitation, in which case, initiatives that promote communication and cultural competency may be beneficial.^{47–49} Further,

providing ready access to the facilities necessary for post-acute TBI patient care across states and regions may be important in reducing geographical disparities in access to appropriate care.^{43,45,50} Overcoming socioeconomic barriers that preclude equitable access to health care through health care reform may improve access to post-acute care for some persons initially treated as inpatients for TBI.^{42–45}

Conclusion

To our knowledge, this is the first study to examine disparities in discharge to rehabilitation and other post-acute care for TBI victims. This study provides a descriptive overview of discharge outcomes for moderate and severe TBI victims and identifies factors that may determine who gets discharged to rehabilitation or other forms of continuing care from inpatient care. It compares these disparities across differing insurance types, including private insurance, Medicare and Medicaid. Trauma surgeons and others directly responsible for recommending TBI patients to inpatient rehabilitation should be aware of the patterns observed in this study, so that non-medical factors possibly affecting decisions regarding patient discharge to an in-patient rehabilitation facility or other post-acute continuing care can be eliminated and efforts can remain focused on improving the long-term patient outcomes.

Understanding the role that demographic, socioeconomic, and regional factors play, and how they might complicate access to continuing care, remains invaluable in ensuring that the benefits of such continuing care are realized among the more vulnerable groups of TBI victims. Our findings thus suggest the need for further local, regional, and nationwide studies to elucidate the reasons behind differential access to potentially beneficial care across racial and insurance groups, so that these race and insurance-based disparities can be eliminated.

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Author Disclosure Statement

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Address correspondence to:
 Anthony O. Asemota, MBBS, MPH
 Department of Surgery
 Johns Hopkins University
 Center for Surgical Trials and Outcomes Research (CSTOR)
 600 N. Wolfe Street, Blalock 618
 Baltimore, MD 21287
 E-mail: aasemota@jhsph.edu