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Differences in Injury Characteristics and Outcomes for American Indian/Alaska Native People Hospitalized with Traumatic Injuries: an Analysis of the National Trauma Data Bank

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Abstract

Objective This study compares characteristics of American Indian/Alaska Natives (AI/AN) and non-Hispanic Whites (NHW) hospitalized for traumatic injury and examines the effect of race on hospital disposition.

Methods Using 2007–2014 National Trauma Data Bank data, we described differences in demographic and injury characteristics between AI/AN ($n = 39{,}656$) and NHWs ($n = 3{,}309{,}484$) hospitalized with traumatic injuries. Multivariable regressions, adjusted for demographic and injury characteristics, compared in-hospital mortality and the risk of discharge to different dispositions (inpatient rehabilitation/long-term care facility, skilled nursing facility, home with home health services) rather than home between AI/AN and NHW patients.

Results Compared to NHWs, a higher proportion of AI/ANs were age 19–44 (49% versus 27%) years and hospitalized with assault-related injuries (25% versus 5%). AI/ANs had lower odds of dying than NHWs during hospitalization (adjusted odds ratio (aOR) 0.72, 95% CI 0.63–0.84). However, AI/ANs also had lower odds than NHWs to discharge to locations with additional health services even after controlling for injury severity (inpatient rehabilitation/long-term care facilities aOR 0.79, 95% CI 0.67–0.93; skilled nursing facility aOR 0.70, 95% CI 0.49–0.98; home with home health services aOR 0.62, 95% CI 0.49–0.79).

Conclusions Injury patterns and acute hospitalization outcomes were significantly different for AI/ANs compared to NHWs. Injury prevention strategies targeting AI/ANs should reflect these differential injury patterns. Outcomes such as disability and access to rehabilitation services should be included when considering the burden of injury among AI/AN communities.

Keywords American Indian · Alaska Native · Trauma · Rehabilitation · Health care disparity · Hospitalization

Abbreviations

aOR	Adjusted odds ratio
AI/AN	American Indian/Alaska Native
GCS	Glasgow Coma Scale
IHS	Indian Health Service
ISS	Injury Severity Score

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MVC Motor Vehicle Collision
NTDB National Trauma Data Bank®
NHW Non-Hispanic White

American Indian and Alaska Native (AI/AN) people are disproportionately affected by traumatic injury. Unintentional injury mortality is two to three times higher for AI/ANs than for non-Hispanic White (NHW) people [1, 2], with mortality and the magnitude of disparity between AI/ANs and NHWs varying between pediatric and adult age groups [1]. Among adolescents [3] and 20- to 64-year-olds [4], AI/ANs are hospitalized for injury at higher rates than the general population. Differences in injury etiology between AI/ANs and the general population exist; a higher proportion of AI/ANs experience motor vehicle-related injury than NHWs (33% versus 25%) in the Washington Trauma Registry [5], and the motor vehicle traffic death rate for AI/ANs was three times higher than for NHWs (41.8 versus 13.4 deaths per 100,000 people) [1]. Single state studies in Washington and Arizona documented a higher rate of intentional injury among AI/ANs compared to Whites, with ethnicity not included in these studies [5, 6]. Beyond mortality and prevalence data, there is limited information on characteristics and outcomes of AI/ANs hospitalized for traumatic injury. Using a national database to investigate injury characteristics and outcomes after trauma hospitalization among AI/ANs will further define the needs of a population that experiences a high burden of traumatic injury.

Racial/ethnic disparities in trauma outcomes exist for other groups [7–9]. Compared with NHW adults hospitalized for traumatic injuries, Black and Hispanic adults were more likely to be uninsured or have public insurance, have intentional injuries, and lower Injury Severity Score (ISS) reflecting less severe injuries [10]. In a meta-analysis, Black race was associated with a higher odds of death during trauma hospitalization compared to NHW race [7]. Functional status is an important outcome for injury survivors. Rehabilitation services are an accepted means of improving functioning and quality of life [10, 11], but studies demonstrate racial/ethnic disparities in access to rehabilitation. After adjusting for demographic and injury characteristics, racial/ethnic disparities in discharge to inpatient rehabilitation facilities exist for Blacks and Hispanics hospitalized for traumatic injuries [10]. However, Black children hospitalized with traumatic brain injury were more likely to discharge to inpatient rehabilitation facilities than NHW or Hispanic children [12]. While there was no disparity in discharge to inpatient rehabilitation facilities among AI/ANs and NHWs with spinal cord injury [13], this study included only one injury type and people age 15 to 64 years. It is unknown whether there are disparities in discharge disposition among AI/ANs hospitalized for traumatic injuries across all types of traumatic injury and age groups.

In order to identify and address the disparities in trauma impact among AI/AN communities, this study aimed to (1) explore differences in demographic and injury characteristics between AI/ANs and NHW in the National Trauma Data Bank (NTDB) and (2) examine the association between AI/AN race and mortality and discharge location after hospitalization for traumatic injury. Because of differences in injury mortality and discharge to inpatient rehabilitation for children seen in other studies [1, 12], the analyses were repeated for the pediatric cohort age 0–18 years old. We hypothesize that (1) there are differences in injury intent and mechanism between AI/ANs and NHWs, (2) a higher proportion of AI/ANs hospitalized for injury will die during hospitalization compared to NHWs, and (3) AI/ANs will be less likely to discharge to inpatient rehabilitation facilities than NHWs.

Methods

Study Setting and Cohort

This study is a retrospective analysis of AI/AN and NHW trauma patients in the NTDB between 2007 and 2014. The American College of Surgeons maintains the NTDB, the largest repository of clinical data specifically for traumatic injuries in the USA. The NTDB contains information on over 7 million trauma cases voluntarily submitted by over 750 participating hospitals [14]. Patients were included in the analysis if their race/ethnicity was reported to NTDB as AI/AN (including those with multiracial identities) or NHW and they had an inpatient admission for a traumatic injury. NTDB has two race fields; if patients were identified as AI/AN in either field, they were included in the analysis as AI/AN. Patients were excluded from the NHW cohort if a non-White race was included in either race field. Patients were also excluded if they were not admitted as an inpatient, or they were discharged to another acute care facility to avoid double counting individual incidents.

Outcomes and Confounders

The primary outcomes of interest were in-hospital mortality and hospital discharge location: home, home with home health services (intermittent skilled nursing and/or rehabilitation therapies delivered at home), skilled nursing facility, inpatient rehabilitation facility or long-term care (grouped due to NTDB combining these categories in some years), or other (including psychiatric hospitals and law enforcement facilities).

Demographic variables include age (categorized as < 5, 5–12, 13–18, 19–44, 45–65, and > 65 years old), gender, and insurance/payer (private insurance, Medicare, Medicaid, uninsured (as reflected by self-pay/not billed status), no fault

automobile/worker's compensation, other government insurance, and other). Injury characteristics include injury mechanism (fall, motor vehicle collision (MVC), pedestrian, cyclist, motorcycle, other transport, firearm, cut/pierced, struck by/against, and other), blunt or penetrating trauma, intent of injury (unintentional, self-inflicted, and assault), Glasgow Coma Scale (GCS) total score (categorized as mild (GCS 13–15), moderate (GCS 9–12), and severe (GCS 3–8)); pulse; and ISS (categorized as mild (ISS < 9), moderate (ISS 9–14), severe (ISS 15–24), and extremely severe (ISS ≥ 25)). Other variables involved in the clinical decisions include primary method of transport to facility (ambulance, helicopter/plane, private vehicle/walk-in, other); hypotension in the emergency department (defined as systolic blood pressure < 90 mmHg for adults and children 10 years or older; < (70 + (2 × age)) mmHg for children age 1–10 years; < 70 mmHg for infants age 1–12 months; and < 60 mmHg for neonates up to 1 month old); and need for a ventilator (dichotomized as "yes" if the number of ventilator days was greater than 0).

Statistical Analysis

In all analyses, we examined the entire cohort and then conducted a stratified analysis for children (< 19 years old) due to expected differences for children. Descriptive statistics were conducted for all the variables, with significance testing through Wald tests from univariate logistic regression with robust standard errors accounting for clustering by facility to compare differences between the AI/AN and NHW cohorts for demographic and injury characteristics and the two outcomes: in-hospital mortality and hospital discharge location. Supplemental Tables 1 and 2 display results from univariate logistic regression to identify areas of discordance between AI/ANs and NHWs for demographic and injury characteristic categories. Multivariable logistic regression with robust standard errors accounting for clustering by facility was used to estimate odds ratios (ORs) and 95% confidence intervals (95% CI) for the risk of in-hospital mortality between AI/AN and NHW patients. Multivariable multinomial logistic regression with robust standard errors accounting for clustering by facility was used to estimate ORs and 95% CIs for the risk of discharge to skilled nursing facility, inpatient rehabilitation/long-term care facility, home with home health services, or other discharge location compared to discharge home as the baseline comparison group between AI/AN and NHW patients who survived to acute hospital discharge. Previous literature found age, hypotension, pulse, total GCS, ISS, and need for a ventilator provided the best risk adjustment model when using NTDB [15]. For both multivariable models, these variables were included in addition to race (AI/AN or NHW) and insurance and the analyses adjusted for clustering by facility to account for correlation in unmeasured covariates between patients treated at the same hospital. While the Hausman test for the Independence of Irrelevant Alternatives assumption for multinomial logistic regression could not be used due to the clustered data, we did compare in logistic regression models each outcome versus discharge to home and found very few differences in the coefficients obtained from multinomial regression.

Multiple imputation of missing variables was considered, but not pursued. Many of the variables in the regression model had missing data of less than 5%, but total GCS had a higher proportion of missing data at (~ 8%). Nearly 80% of those missing a total GCS score did not have a TBI diagnostic code recorded. A sensitivity analysis was run where all those missing a total GCS score were categorized as having a total GCS in the mild range of 13–15. This did not change the magnitude or direction of the findings of the complete case regression analyses, so we did not attempt to replace missing data.

All analyses were conducted with STATA (version 13.1 Statcorp: College Station, TX).

Results

Of the total 3,349,140 patients included, 39,656 (1.2%) identified as AI/AN. Of the AI/AN individuals, 741 (1.9%) were identified as AI/AN in combination with another race. Table 1 displays demographic characteristics. The total cohort of AI/ANs had a higher proportion of males (66.6% versus 58.2%) and adults age 19–44 (49.4% versus 27.4%) but a lower proportion of elders 65 years or older (9.1% versus 29.7%) compared to NHWs. Among children, there was a similar proportion of males in the AI/AN and NHW cohorts. There were significant differences in payer, with AI/ANs more likely than NHWs to be covered by Medicaid (28.8% versus 8.6%) or other government insurance (15.3% versus 1.7%). Over half of AI/AN children were covered by Medicaid, compared to less than 25% of NHW children.

There were several differences in injury characteristics between the AI/AN and NHW cohorts, shown in Table 2. AI/ANs were more likely to have intentional injuries than NHW, with higher proportion of assault (24.5% for AI/ANs versus 5.2% for NHW) and self-inflicted injuries (2.4% versus 1.4% for AI/ANs and NHWs respectively). As compared with patients with unintentional injuries, those with injuries from assault were six times more likely to be AI/AN rather than NHW (OR 6.1, 95% CI 4.8–7.7, Supplemental Table 2). AI/AN children also had a higher proportion of intentional injuries (assault and self-inflicted) than NHW children (13.3% versus 4.9%). The proportion of people injured in falls was much lower in AI/ANs than NHWs (27.7% versus 47.9%), but

Table 1 Demographic characteristics among American Indians/Alaska Natives and non-Hispanic Whites hospitalized for injury in the National Trauma Data Bank, 2007–2015

Variable (%)	AI/AN ($n = 39,656$)	NHW ($n = 3,309,484$)	Variable (%)	AI/AN children ($n = 7334$)	NHW children ($n = 454,367$)
Age (years)*			Age (years)ǂ		
< 5	5.3	3.2		28.5	23.4
5–12	5.4	4.4		29.5	32.2
13–18	7.8	6.1		42.1	44.3
19–44	49.4	27.4			
45–64	22.2	24.8			
≥ 65	9.1	29.7			
Missing	0.8	4.3			
Sex*			Sex		
Male	66.6	58.2		64.1	65.2
Female	33.4	41.7		35.9	34.8
Missing	< 0.1	0.1			
Insurance status*			Insurance status*		
Private insurance	13.6	29.1		17.4	49.9
Medicare	9.9	28.5		0.3	0.3
Medicaid	28.8	8.6		51	23.7
Uninsured	16.1	10.5		9.5	5.9
No Fault Auto, Worker's Comp	4.9	8.7		3.6	5.1
Other government insurance	15.3	1.7		8.6	2.1
Other	4.9	4.7		3.9	4.6
Missing	6.5	8.2		5.6	8.3

AI/AN American Indian/Alaska Native, *NHW* non-Hispanic White

*p value < .001 for differences between AI/AN and NHW cohorts

ǂp value < .01 for differences between AI/AN and NHW cohorts. P values obtained from Wald tests from univariate logistic regression with robust standard errors accounting for clustering by facility to compare differences between the AI/AN and NHW cohorts

"cut/pierce" and "struck by/against" were much higher among AI/ANs (9.0% versus 2.6% and 14.9% versus 5.7%, respectively). AI/ANs were more likely than NHWs to have an ISS under 9 (49.0% versus 42.2%), representing less severe injury status, but had a similar proportion with ISS of 25 or greater (7.4% versus 7.2%).

In both the full cohort and pediatric sub-group, AI/ANs were more likely to have been transferred from another healthcare facility (49.0% versus 29.5% for the entire cohort and 58.0% versus 43.4% for children) and to have been transported by air (30.5% versus 12.6% and 33.2% versus 15.0% for children). A higher proportion of AI/ANs were admitted to the operating room or intensive care unit from the emergency department compared to NHWs (16.6% versus 12.2% and 25.1 versus 22.1%, respectively) (Table 2).

Outcomes

Without adjusting for injury variables, fewer AI/ANs died in-hospital due to traumatic injuries compared to NHWs (2.6% AI/ANs versus 3.9% NHW). The differences in the distribution of disposition from acute care hospitalization between AI/ANs and NHWs were also statistically different. Almost 80% of AI/AN people were discharged home without services, compared to only 62% of NHWs. NHWs were more likely than AI/ANs to discharge to inpatient rehabilitation/long-term care facilities (10.1% versus 7.2%) or skilled nursing facilities than AI/ANs (14.6% versus 5.4%) (Table 2).

After adjusting for demographic and injury characteristics (Table 3), AI/ANs have lower odds of dying during trauma hospitalization than NHWs (OR 0.72, 95% CI 0.63–0.84). In general, increasing age was associated with higher odds of death, but children under 5 years had higher odds of death than adults age 19–44 years (OR 1.33, 95% 1.22–1.45). Being uninsured was related to higher odds of death (OR 1.54, 95% CI 1.45–1.64), as was having Medicare insurance (OR 1.48, 95% CI 1.41–1.55). Among children, race was not independently associated with odds of death. Children under age 5 years had higher odds of death than teenagers (OR 2.01, 95% CI 1.79–2.26). Insurance status was also

Table 2 Injury and clinical characteristics among American Indians/Alaska Natives and non-Hispanic Whites hospitalized for injury in the National Trauma Data Bank, 2007–2015

Variable (%)	AI/AN ($n = 39,656$)	NHW ($n = 3,309,484$)	Variable (%)	AI/AN children ($n = 7334$)	NHW children ($n = 454,367$)
Intent of injury*			Intent of injury*		
Unintentional	71.6	92.5		85.2	93.8
Assault	24.5	5.2		11.8	4.2
Self-inflicted	2.4	1.4		1.5	0.7
Other/unknown	1.2	0.4		1.3	0.5
Missing	0.2	0.5		0.2	0.7
Injury type*			Injury type*		
Blunt	78.7	89.4		78	84.9
Penetrating	12.0	4.4		8	3.5
Other	9.3	6.2		14	11.7
Injury mechanism*			Injury mechanism*		
Fall	27.7	47.9		29.6	36.1
MVC	21.2	18.5		20	17.3
Pedestrian	4.6	2.6		4.8	3.3
Cyclist	2.0	2.6		4.3	5.5
Motorcycle	1.7	5.2		0.7	1.5
Other transport	0.1	0.1		0.1	<0.1
Firearm	2.8	1.6		2.5	1.1
Cut/pierce	9.0	2.6		5.3	2.2
Struck by/against	14.9	5.7		9.2	10.7
Other	6.2	3.1		7.3	5.5
Missing	9.8	10.1		16.2	16.8
Transferred from another facility*			Transferred from another facility*		
Yes	49.0	29.5		58	43.3
No	50.6	70.3		41.7	56.5
Missing	0.4	0.2		0.3	0.2
Mode of transport*			Mode of transport*		
Ambulance	52.2	67.2		42.9	54.6
Helicopter/plane	30.5	12.6		33.2	15.0
Private vehicle/walk-in	11.1	14.2		17.8	23.6
Other	0.6	0.7		0.5	0.7
Missing	5.6	5.3		5.5	6.1
Hypotensive in ED			Hypotensive in ED		
Yes	5.7	5.5		11.0	9.6
No	94.3	94.5		89.0	90.4
Injury Severity Score*			Injury Severity Score		
< 9	49.0	42.2		54.8	53.1
9–14	30.3	35.7		27.7	29.1
15–24	11.9	12.3		10.2	9.3
≥ 25	7.4	7.2		5.8	5.4
Missing	1.4	2.6		1.5	3.2
Total GCS*			Total GCS*		
13–15	77.7	84.5		80	85.2
9–12	3.6	2.0		2.6	1.6
3–8	11.0	5.8		9.1	5.3
Missing	7.7	7.7		8.3	7.9
ED disposition*			ED disposition*		

Table 2 (continued)

Variable (%)	AI/AN ($n = 39,656$)	NHW ($n = 3,309,484$)	Variable (%)	AI/AN children ($n = 7334$)	NHW children ($n = 454,367$)
Floor bed	43.2	51.4		45.9	52.1
ICU	25.1	22.1		23.2	19.6
OR	16.6	12.2		19.8	16.6
Telemetry/step-down	5.1	7.9		2.0	3.2
Observation (< 24 h)	2.5	2.4		1.9	3.7
N/A—directly admitted	5.4	2.5		5.3	3.0
Missing	2.0	1.5		1.7	1.8
Hospital disposition*			Hospital disposition*		
Deceased/expired	2.6	3.9		1.6	1.3
Home, no services	79.7	61.7		91.2	91.6
Home with home health services	2.0	5.4		1.2	2.1
Skilled nursing facility	5.4	14.6		0.4	0.3
Inpatient rehabilitation/long-term care facility	7.2	10.1		4.2	2.9
Other	2.6	4.1		0.9	1.1
Missing (including not applicable)	0.5	0.8		0.6	0.8

Glasgow Coma Scale scores are used clinically to describe the severity of TBI, where 13–15 indicates mild, 9–12 moderate, and 3–8 severe injury. Other hospital disposition included intermediate care facilities, hospice, leaving against medical advice, court systems, psychiatric hospital, and other institutions

AI/AN American Indian/Alaska Native, *NHW* non-Hispanic White, *ED* Emergency Department, *GGS* Glasgow Coma Scale, *ICU* intensive care unit, *OR* operating room

*p value < .001 for differences between AI/AN and NHW cohorts

ǂp value < .01 for differences between AI/AN and NHW cohorts

§p value < .05 for differences between AI/AN and NHW cohorts. p values were obtained from Wald tests from univariate logistic regression with robust standard errors accounting for clustering by facility to compare differences between the AI/AN and NHW cohort

associated with odds of mortality, with children covered by Medicare (OR 5.29, 95% CI 2.62–10.65) or uninsured children (OR 2.20, 95% CI 1.85–2.62) having higher odds of death.

Among those who survived to hospital discharge, the relative odds of receiving a discharge outcome other than home without home health services after trauma hospitalization was lower for AI/ANs than NHWs across all discharge outcomes after holding demographic and injury characteristics constant. As shown in Table 4, AI/ANs had lower odds than NHWs to be discharged to an inpatient rehabilitation/long-term care facility (aOR 0.79, 95% CI 0.67–0.93), a skilled nursing facility (aOR 0.70, 95% CI 0.49–0.98), home with home health services (aOR 0.41, 95% CI 0.30–0.55), or to other locations (aOR 0.62, 95% CI 0.49–0.79). Children had lower odds than adults to be discharged to locations other home. For instance, compared to adults age 19–44, children in all age groups had lower odds of discharge to an inpatient rehabilitation/long-term care facility (children < 5 years aOR 0.18, 95% CI 0.13–0.25; age 5–12 years aOR 0.19, 95% CI 0.15–0.24; age 13–18 aOR 0.61, 95% CI 0.57–0.66). Holding all variables constant, the odds of being discharged to a location other than home without health services was also lower for all discharge locations except "Other dispositions" for people without insurance compared to those with private insurance.

When comparing among children, the odds of being discharged to an inpatient rehabilitation/long-term care facility are greater by a factor of 1.41 for AI/AN children than NHW children holding all other variables constant (aOR 1.41, 95% CI 1.15–1.73) (Supplemental Table 3). Younger children had lower odds than teenagers to be discharged to inpatient rehabilitation/long-term care facilities rather than home (children < 5 years aOR 0.31, 95% CI 0.22–0.45; children 5–12 years aOR 0.32, 95% CI 0.26–0.41). Relative to discharge home, uninsured children had decreased odds of discharge to an inpatient rehabilitation/long-term care facility (aOR 0.64, 95% CI 0.53–0.76) compared to children with private insurance.

Discussion

This analysis of the NTDB found several notable differences in the demographics, injury characteristics, and discharge disposition between AI/ANs and NHWs hospitalized for traumatic injuries. A majority of the AI/AN cohort was working age, with a relatively small percentage (9.1%) over age 65 years. In contrast, one third of the NHW cohort was comprised of those over 65 years. Over one quarter of the AI/AN

Table 3 Factors associated with in-hospital mortality among American Indians/Alaska Natives and non-Hispanic Whites in the National Trauma Data Bank, 2007–2015

	All ages		Children (0–18)	
Factors	aOR	95% CI	aOR	95% CI
Race/ethnicity				
NHW	Reference		Reference	
AI/AN	0.72	(0.63–0.84)	0.81	(0.62–1.06)
Age group				
< 5 years	1.33	(1.22–1.45)	2.01	(1.79–2.26)
5–12	0.70	(0.62–0.80)	0.92	(0.82–1.04)
13–18	0.89	(0.84–0.94)	Reference	
19–44	Reference			
45–64	2.20	(2.12–2.28)		
65+	9.80	(8.87–10.83)		
Hypotensive in ED	2.93	(2.79–3.07)	4.66	(3.94–5.51)
Heart rate in ED	1.00	(1.00–1.00)	1.00	(0.99–1.00)
Injury Severity Score				
< 9	Reference		Reference	
9–14	1.97	(1.81–2.13)	1.76	(0.88–3.53)
15–24	2.96	(2.68–3.27)	3.86	(1.70–8.78)
25+	11.57	(10.28–13.04)	23.56	(10.38–53.49)
Total GCS				
3–8	Reference		Reference	
9–12	0.41	(0.38–0.43)	0.09	(0.07–0.12)
13–15	0.14	(0.13–0.16)	0.02	(0.01–0.03)
Need for ventilator	4.80	(4.34–5.31)	1.25	(1.02–1.54)
Insurance				
Private	Reference		Reference	
Medicare	1.48	(1.41–1.55)	5.29	(2.62–10.65)
Medicaid	0.99	(0.94–1.05)	1.05	(0.91–1.22)
Uninsured	1.54	(1.45–1.64)	2.20	(1.85–2.62)
No fault auto/worker's compensation	0.81	(0.75–0.88)	0.96	(0.83–1.11)
Other government	1.09	(0.98–1.22)	0.78	(0.59–1.05)
Other	1.13	(0.98–1.30)	1.18	(0.95–1.47)

Multivariable logistic regression was used to compare the risk of in-hospital mortality between AI/AN and NHW patients hospitalized for injury at facilities submitting data to the NTDB

aOR adjusted odds ratio, *AI/AN* American Indian/Alaska Native, *NHW* non-Hispanic White, *ED* Emergency Department, *GGS* Glasgow Coma Scale

sample, but less than 10% of the NHW sample, was hospitalized for an intentional injury. When adjusting for key demographic and injury severity characteristics, AI/ANs had lower odds of death during hospitalization than NHWs, but higher odds than NHWs to be discharged home without home health services rather than to an inpatient rehabilitation or long-term care facility, skilled nursing facility, or home with home health services. AI/AN children, however, had higher odds than NHW children to be discharged to inpatient rehabilitation/long-term care facilities rather than home.

The decreased odds of in-hospital trauma mortality for AI/ANs compared to NHWs found in this study contrasts with the higher rate of injury mortality for AI/ANs compared to NHWs found in studies that linked Indian Health Service (IHS) registration records with the US National Death Index [1, 16]. However, differences in pre-hospital factors—such as rural location or access to emergency medical services—likely contribute to increased AI/AN injury mortality at the scene of the injury, meaning those that survive to hospitalization reflect a population at lower risk of death [17, 18]. This further highlights the importance of primary injury prevention among AI/AN communities in decreasing injury mortality. IHS's Injury Prevention Program and several tribal communities have developed culturally and community-specific initiatives to prevent injuries [18–22]. Based on the injury patterns found in this study, efforts to reduce injuries among younger

Table 4 Factors associated with location of discharge after injury hospitalization among American Indians/Alaska Natives and non-Hispanic Whites in the National Trauma Data Bank, 2007–2015

	Inpatient rehabilitation/long-term care		Skilled nursing facility		Home with home health services		Other dispositions	
Factors	aOR	95% CI	aOR	95% CI	aOR	95% CI	aOR	95% CI
Race/ethnicity								
NHW	Reference		Reference		Reference		Reference	
AI/AN	0.79	(0.67–0.93)	0.70	(0.49–0.98)	0.41	(0.30, 0.55)	0.62	(0.49–0.79)
Age group								
< 5 years	0.18	(0.13–0.25)	0.09	(0.06–0.13)	0.25	(0.19, 0.32)	0.10	(0.08–0.13)
5–12	0.19	(0.15–0.24)	0.03	(0.02–0.04)	0.25	(0.20, 0.32)	0.10	(0.08–0.15)
13–18	0.61	(0.57–0.66)	0.16	(0.15–0.18)	0.55	(0.51, 0.60)	0.49	(0.45–0.54)
19–44	Reference		Reference		Reference		Reference	
45–64	1.92	(1.86–1.98)	5.04	(4.78–5.31)	1.69	(1.60, 1.77)	1.55	(1.50–1.61)
65+	5.80	(5.38–6.25)	31.09	(28.28–34.17)	2.99	(2.76, 3.24)	3.23	(2.97–3.51)
Hypotensive in ED	1.42	(1.37–1.48)	1.48	(1.42–1.55)	1.25	(1.18, 1.33)	1.29	(1.22–1.36)
Heart rate in ED	1.00	(1.00–1.01)	1.00	(1.00–1.01)	1.00	(1.00, 1.00)	1.01	(1.01–1.01)
ISS								
< 9	Reference		Reference		Reference		Reference	
9–14	2.83	(2.69–2.97)	2.28	(2.20–2.37)	1.46	(1.38, 1.54)	1.79	(1.66–1.93)
15–24	3.51	(3.26–3.78)	1.64	(1.48–1.73)	1.46	(1.36, 1.56)	2.20	(2.00–2.42)
25+	9.02	(8.28–9.83)	4.13	(3.78–4.51)	2.24	(2.04, 2.47)	5.28	(4.63–6.01)
Total GCS								
3–8	Reference		Reference		Reference		Reference	
9–12	0.84	(0.79–0.90)	1.09	(0.99–1.20)	0.99	(0.91, 1.08)	1.04	(0.96–1.13)
13–15	0.52	(0.47–0.57)	0.60	(0.53–0.67)	1.03	(0.93, 1.14)	0.61	(0.54–0.69)
Need for ventilator	3.54	(3.18–3.93)	2.38	(2.12–2.66)	1.58	(1.38, 1.81)	3.07	(2.69–3.51)
Insurance								
Private	Reference		Reference		Reference		Reference	
Medicare	1.82	(1.72–1.93)	2.33	(2.17–2.51)	1.64	(1.53, 1.76)	2.11	(1.94–2.28)
Medicaid	1.03	(0.97–1.09)	1.76	(1.64–1.88)	1.06	(0.96, 1.16)	1.64	(1.50–1.79)
Uninsured	0.45	(0.41–0.49)	0.36	(0.33–0.40)	0.54	(0.47, 0.62)	1.05	(0.94–1.18)
No fault auto/worker's compensation	1.12	(1.03–1.23)	0.75	(0.68–0.83)	1.21	(1.08, 1.37)	1.15	(0.99–1.33)
Other government	0.81	(0.72–0.92)	0.80	(0.71–0.91)	0.79	(0.57, 1.11)	1.14	(0.99–1.32)
Other	0.84	(0.72–0.98)	1.34	(0.90–1.99)	0.86	(0.65, 1.13)	1.64	(1.34–2.02)

Multivariable multinomial regressions were used for this analysis of people who survived to hospital discharge, with discharge to home without home health services as the baseline comparator. Other dispositions included psychiatric hospitals and law enforcement facilities. A stratified analysis for children 18 years old and younger can be found in Supplemental Table 3

aOR adjusted odds ratio, *AI/AN* American Indian/Alaska Native, *NHW* non-Hispanic White, *ED* Emergency Department, *ISS* Injury Severity Score, *GGS* Glasgow Coma Scale

populations, and those related to falls, motor vehicle collisions, self-inflicted injuries, and assaults would be beneficial for AI/AN communities.

Most patients were discharged home without home health services, with a higher proportion of AI/ANs than NHW receiving this disposition. Given the severity of clinical and injury characteristics of this hospitalized sample, the known benefits of rehabilitative services, and the known barriers and limited access to community resources for Medicaid patients and patients from minority racial/ethnic groups [8, 23], this is concerning and could contribute to disparities in functional, vocational, and other outcomes. Further study is needed to determine whether AI/ANs who discharge directly home without health services after trauma hospitalization have their long-term functional needs adequately addressed.

In addition, this study found that AI/ANs who survived to hospital discharge had a lower odds of being discharged to an inpatient rehabilitation/long-term care facility rather than home compared to NHWs, even when controlling for insurance status. This corresponds with other analyses of the

NTDB that found minority race was associated with decreased likelihood of discharge to inpatient rehabilitation compared to NHWs, though these analyses did not include specific analyses of AI/AN people [10, 24, 25]. The only other NTDB analysis focusing specifically on AI/ANs found that there was no racial disparity in discharge to rehabilitation facilities after hospitalization for spinal cord injury [13]. Spinal cord injury is a diagnosis with a clear indication for intensive rehabilitation, with NTDB analyses finding 47% of adults with spinal cord injury discharged to an inpatient rehabilitation facility [13] compared to only 5% of adults with all injury types [10]. To be admitted to an inpatient rehabilitation facility, one must have physiatry and therapy consultations, be deemed a candidate for and accepted by an inpatient rehabilitation facility, and agree to discharge to an inpatient rehabilitation facility. It is unclear at what point in this process the disparity in discharge to inpatient rehabilitation facility for AI/ANs arises, but many of these steps involve individual decision making where implicit bias, social determinants of health, or lack of geographically accessible rehabilitation services could impact access to inpatient rehabilitation facilities for AI/ANs.

While overall AI/ANs had lower odds of discharge to inpatient rehabilitation/long-term care facilities, we found AI/AN children had higher odds than NHW children to discharge to inpatient rehabilitation/long-term care facilities. In a separate study of data from inpatient rehabilitation facilities across the USA, AI/AN children admitted to inpatient rehabilitation facilities with traumatic brain injuries had higher motor function scores at admission compared to NHW children [26]. It could be that AI/AN children are admitted to inpatient rehabilitation facilities at higher rates and with higher functional levels than NHW children because they lack access to pediatric rehabilitation therapists in their home communities; differential access to outpatient rehabilitation services has been shown in Hispanic populations [8]. Without access to outpatient or home health rehabilitation services, an inpatient rehabilitation facility admission may be the only option for rehabilitation services to address functional impairments. Further research examining these associations is recommended.

This study is limited by several factors. Racial misclassification of AI/ANs is common in healthcare records [27–29], and it is possible that more accurate identification of AI/ANs in NTDB would affect the analyses. Also, the NTDB is not a population-based sample [14], and the facilities contributing data to NTDB may not represent all of the facilities at which AI/AN people receive their trauma care. We excluded patients from the multivariable analyses if they were missing data, increasing the potential for bias if the data are missing because of a factor related to the outcomes measured [30]. Aligned with standard methods in NTDB analyses, we did not include all the individual and injury factors that may impact in-hospital mortality, instead choosing to use the variables found by Haider et al. to be the best predictors of mortality [15]. Similarly, not all the individual or injury factors that influence discharge to inpatient rehabilitation could be included in the analysis. Functional status, a key factor in admission to inpatient rehabilitation facilities, is not collected by NTDB, though it is expected that more severe injuries—captured in this study using ISS—result in more functional limitations. There are other factors affecting inpatient rehabilitation candidacy, such as ability to participate in 3 h of therapy daily, which are not collected in NTDB. Finally, referral to or utilization of outpatient clinic-based rehabilitation services is not captured in NTDB, so this analysis cannot address this means of accessing rehabilitation services after traumatic injury hospitalization.

Conclusions and Public Health Implications

Among those hospitalized for injuries at hospitals participating in the NTDB, AI/ANs are younger, more likely to have an intentional injury (assault or self-inflicted), and have a lower odds of dying during hospitalization than NHWs. After hospitalization for traumatic injury, AI/ANs are more likely to be discharged home without home health services and have lower odds than NHWs to be discharged to rehabilitation facilities. There are several key points of intervention in the clinical care process that might improve referral rates to rehabilitation facilities, beginning with universal assessment of rehabilitation needs and improved access to rehabilitation services in the community. The impact of the rehabilitation referral pattern on long-term functional outcomes for AI/ANs after injury hospitalization is unknown and requires further study. Outcomes such as measures of functional impairment and access to and utilization of rehabilitation services should be included when considering the burden of injury for AI/AN populations.

Compliance with Ethical Standards

The Institutional Review Board determined the previously collected, de-identified data in this study, does not meet regulatory definition of human subject research, and thus did not require Institutional Review Board approval.

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Conflicts of Interest The authors declare that they have no conflicts of interest to disclose.

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