PEDIATRIC TRAUMATIC BRAIN INJURY: DO RACIAL/ETHNIC DISPARITIES EXIST IN BRAIN INJURY SEVERITY, MORTALITY, OR MEDICAL DISPOSITION?

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Introduction: Little is known regarding pediatric racial/ethnic disparities. We sought to determine if racial/ethnic disparities exist in the severity, mortality, or medical disposition of pediatric traumatic brain injury (TBI).

Methods: We analyzed data from a comprehensive trauma database assembled at a large independent children's hospital. Among all patients evaluated by the trauma service in the emergency department (ED), cases of TBI were identified ($N=1035$). Analyses contrasted non-Hispanic White children with all others (minority children). The relationship of race to patient characteristics, brain injury severity, mortality, and medical disposition (hospital admission, intensive care unit admission) was analyzed by using bivariable approaches and multivariate logistic regression. The latter controlled for age, overall injury severity, and insurance status.

Results: Although sociodemographic characteristics did not differ, the mechanism of injury was significantly different ($P<.001$); minority children were more likely to have been a pedestrian or cyclist struck by a vehicle. Minority children were less likely to require transfer to the ED for treatment and were more likely to be publicly insured ($P<.001$). No differences in brain injury severity, mortality, or medical disposition were observed with both bivariable and multivariable approaches.

Conclusions: This study is one of the first to examine potential disparities in trauma and contributes to the small but growing literature in pediatric health disparities. Multiple explanations are explored, several with potential implications for reducing disparities in other health conditions. Identifying conditions in which evaluation and treatment appears to be free of disparities may provide insights for subsequent investigations and interventions. (*Ethn Dis*. 2005;15 [suppl 5]:S5-51–S5-56)

Key Words: Children, Racial/Ethnic Disparities, Traumatic Brain Injury

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INTRODUCTION

Among children ≤14 years of age, traumatic brain injury (TBI) results in an estimated 29,000 hospitalizations, 400,000 emergency department (ED) visits, and 3000 deaths annually, which makes it the leading cause of death and permanent disability in children.[1,2] Survivors of TBI may suffer from impairments in intellectual functioning, language, nonverbal skills, attention, memory, concentration, coordination, balance, vision, and executive functioning.[3] TBI can also result in emotional and behavioral problems, as well as disorders such as epilepsy.[3,4]

Certain groups appear to be disproportionately affected by TBI and its consequences. TBI affects African Americans more often than other races, particularly among young males.[5] African Americans also have the highest death rates from TBI.[2] Racial and ethnic disparities also exist in emergency care for mild TBI. For example, although African Americans have a 35% higher incidence of TBI than Whites,[6] they are less likely to have appropriate follow-up after ED discharge.[7] Additionally, non-Whites are significantly more likely to be seen by a physician in training and are more likely not to return for a follow-up visit after ED discharge.[8]

Most of these research studies of TBI focused on adult populations. Fewer research studies include data from children and/or adolescents. As a result, very little information is available related to TBI and pediatric disparities, although the limited available literature suggests similar disparities may exist for children. For instance, estimated TBI rates for African-American children ≤4 years of age are 40% higher than those for White children.[9] Identifying these health disparities is the first step to eliminating them and improving health care for all. Despite the importance of this heath condition, it has not been widely explored with respect to disparities.

The relative paucity of information on disparities in pediatric TBI is not surprising. While distressing disparities have been observed in both the epidemiology and treatment of diverse medical and surgical conditions in adults,[10] considerably less is known regarding pediatric disparities generally. The purpose of these analyses was to determine if significant racial/ethnic disparities exist in the severity, death rate, or medical disposition of children with TBI.

In this article we use information in medical records to categorize children with respect to race/ethnicity by using traditional medical groupings such as African American. In doing so, we need to clarify our view that race is a sociocultural designation rooted in the history of Western colonial expansion generally and debate in the United States regarding slavery specifically.[11] Racial designations are easily misunderstood as reflecting biological or inherited traits leading to specific health conditions or risks.[12] Furthermore, while a complete discussion of the relationship between socioeconomic sta-

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tus and race is beyond the scope of this paper, reducing health disparities requires addressing both.[13]

METHODS

Study Population

Data for this study were obtained from a series of all patients evaluated by the trauma service in the ED of a large independent children's hospital between January 1, 2001, and August 1, 2004. The Centers for Disease Control and Prevention case definition for TBI was used to identify cases of craniocerebral trauma. The following International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnostic codes are included in the definition of traumatic brain injury: 1) 800.0–801.9 (fracture of the skull or base of the skull); 2) 803.0–804.9 (other and unqualified and multiple fractures of the skull); 3) 850.0–854.1 (intracranial injury, including concussion, contusion, laceration, and hemorrhage); 4) 873.0–873.9 (other open wound of head); and 5) 959.01 (head injury not otherwise specified). All charts were reviewed by specially trained research nurses with a standard abstraction form. The protocol for abstraction includes careful specification of variable definitions and timing (eg, Glasgow coma score [GCS] is to be recorded at specific time points, including entry to the ED and discharge). Patients were eligible for inclusion in analyses if they presented with injuries that included any traumatic brain injury, including blunt force, penetrating injuries, and multisystem trauma. Subgroup analyses were conducted of those who were admitted to compare factors associated with intensive care unit (ICU) admission versus routine admission. The research division of the hospital's trauma service maintains the database with approval from the Children's National Medical Center's institutional review board.

Variables Considered in Analyses

To examine the relationship of race to TBI mortality and medical disposition, selected sociodemographic variables were abstracted from charts including race, gender, age, insurance status (public vs all other). Preliminary analyses demonstrated no statistically significant or clinically relevant differences in outcome measures were found among children who were other than non-Hispanic Whites (African American, Latino, Asian, other). Furthermore, the small numbers of children in several of these groups precluded their separate consideration. Therefore, analyses were conducted by comparing non-Hispanic White children to all others, which is consistent with examining the effects of socioculturally defined minority status on TBI severity, medical disposition, and outcome.[11–13] Injury-relevant variables included mechanism of injury (fall vs motor vehicle crash vs pedestrian/cyclist struck vs other) and transfer status (direct ED admit vs transfer from outside hospital to ED). Medical factors considered included final systolic blood pressure measured in ED (<50th percentile for age vs all others), first GCS in ED (3–15, where lower score indicates more severe brain injury), and a validated injury severity score (ISS) (1–50; higher values represent more severe overall injury). Finally, as suggested above, we investigated both mortality before discharge and medical disposition from the ED (ICU vs. routine care, admission vs. discharge).

Statistical Analysis

Bivariable analyses included Pearson chi-square evaluation of differences in proportions and unpaired *t* tests to compare continuous variables. Multivariable analysis was conducted by using logistic regression procedures, all of which included ISS (as a measure of injury severity), insurance status (as a measure of socioeconomic status), and age as covariates in order to most accurately appreciate the relationship of race to outcomes described above. GCS was not included because it tightly covariated with ISS, which resulted in multicollinearity and did not differ significantly between the groups being compared. All analyses were conducted by using Stata Statistical Software release 8.0 (StataCorp LP, College Station, Texas), and $P<.05$ defined significant results.

RESULTS

During the study period, 1035 children were evaluated by the trauma service for TBI. The average age of the study population was 7.3 ± 5.1 years (mean ± SD), with a range from 7 days to 19 years old. The study group was 49% African American, 28% non-Hispanic White, 8% Hispanic, and 14% other races including American Indian and Asian. Children were injured in Maryland (59%), the District of Columbia (25%), Virginia (6%), or other states in the mid-Atlantic (10%).

Most patients (33.3%) were injured in a fall, with another 24.1% in a motor vehicle crash, and 13.1% were a pedestrian/cyclist struck by a vehicle. The remaining 29.5% were injured through a variety of mechanisms including nonaccidental, inflicted trauma. Slightly more than one quarter (26.7%) were transferred to the study hospital from another ED. Most children had mild injury as assessed in the ED by a low mean ISS of 9.7 ± 8.5 (interquartile range [IQR] 4–27), and GCS 13.2 ± 3.9.

As shown in Table 1, a variety of patient characteristics were compared between the two racial/ethnic groups (non-Hispanic White vs racial/ethnic minorities). Although sociodemographic characteristics did not differ, the mechanism of injury was significantly different (chi-square $P<.001$); minority children were much more likely to have been a pedestrian or

Table 1. Factors associated with race/ethnicity among children with traumatic brain injury: results of bivariate comparisons (*N*=1035)

	Non-Hispanic White		All Minorities		
		n		*n*	*P* value*
Male gender (%)	64	187	67.8	504	NS
Age group, y (%)					
≤1	18.8	55	20.2	150	NS
2–5	20.6	60	27.3	203	
6–11	29.4	86	26.1	194	
>11	31.2	91	26.4	196	
Mechanism of injury (%)					
Fall	37.7	110	31.6	235	<.001
Motor vehicle crash	26.4	77	23.2	172	
Pedestrian/cyclist	4.1	12	16.7	124	
Other	31.8	93	28.5	212	
Transfer from other hospital (%)	34.9	102	23.4	174	<.001
Injury severity score (mean [95% CI])	9.8 (8.8–10.8)	292	9.7 (9.0–10.3)	743	NS†
Hospital admission (%)	56.8	166	56.1	417	NS
ICU admission (%)	25.7	75	23.0	171	NS
Public insurance (%)	16.2	40	51.7	287	<.001
Mortality (%)	3.1	9	4.3	32	NS
Low final SBP ED (% <50th percentile for age)	31.2	65	24.8	149	NS

* *P* value determined by Pearson chi-square test unless noted otherwise.
† *P* value determined by using the Student *t* test.
CI: confidence interval, ED: emergency department, ICU: intensive care unit, SBP: systolic blood pressure.

cyclist struck by a motor vehicle. Similarly, non-Hispanic White children were more likely to have been transferred from other hospitals (which reflects the geographic distribution of racial groups in the region) and much less likely to be publicly insured (which reflects socioeconomic disparities in the region). Neither ISS nor final systolic blood pressure in the ED differed in the groups compared. Finally, bivariate comparisons of mortality, hospital admission, and ICU admission are also shown. Approximately 57% of all children in the data set were admitted to the hospital, approximately one quarter admitted to the ICU, and 3%–4% died; none of these outcomes differed by race/ethnicity. Similarly, as shown in Table 2, no differences were seen in GCS obtained at either ED admission and discharge in the two groups of children, which suggests they experienced similarly severe TBI. Additional analyses of continuously distributed GCS (results not shown) produced similar results.

In Table 3 the effects of minority status on mortality and medical disposition are compared in all children with complete data required for multivariable analysis (*N*=914). As expected, injury severity is highly predictive of death, severe TBI as defined by GCS <9 on arrival to the emergency department, hospital admission, and admission to the ICU. Age also significantly affects mortality (younger children are more likely to die), but neither hospital nor ICU admission. More relevantly, neither race nor insurance status is related to either mortality or these measures of medical disposition.

To examine this issue more thoroughly, we considered the relationship of race to medical disposition in the group of less severely injured children (*n*=608). Excluded from these analyses are children in the top one third of injury severity with ISS >11. We undertook these subgroup analyses be-

Table 2. Relationship of race/ethnicity to brain injury severity at two time points among children with TBI: results of bivariate comparisons

	Arrival ED GCS		Final ED GCS		
	Non-Hispanic White	All Minorities	Non-Hispanic White	All Minorities	*P* value
Mild/moderate TBI (*n*)	90.5% (218)	86.2% (536)	89.8% (202)	85.4% (510)	NS
Severe TBI (*n*)	9.5% (23)	13.8% (86)	10.2% (23)	14.6% (87)	NS

Mild/moderate TBI defined as GCS 9–15; severe TBI defined as GCS 3–8. *P* value determined by Pearson chi-square test. ED: emergency department, GCS: Glasgow coma score, TBI: traumatic brain injury.

Table 3. Relationship of race/ethnicity to brain injury severity, mortality, and medical disposition among children with TBI: results of multivariate logistic regression (*N*=914)

	Odds Ratio	95% CI	*z*	*P* value
Severe TBI (GCS≤8)*				
Age	.94	.89–.99	−2.52	.012
ISS	.86	.84–.89	−1.45	.000
Public insurance	.80	.48–1.33	−.87	NS
Non-Hispanic White	.68	.38–1.23	−1.28	NS
Mortality				
Age	.85	.78–.93	−3.38	.001
ISS	.82	.78–.86	−8.25	.000
Public insurance	.74	.32–1.70	−.70	NS
Non-Hispanic White	.85	.32–2.24	−.33	NS
Hospital admission				
Age	.99	.96–1.02	−.59	NS
ISS	1.12	1.09–1.14	9.48	.000
Public insurance	1.34	.97–1.84	1.79	NS
Non-Hispanic White	1.00	.72–1.38	.00	NS
ICU admission				
Age	.97	.93–1.00	−1.63	NS
ISS	1.16	1.13–1.18	12.69	.000
Public insurance	1.20	.82–1.77	.97	NS
Non-Hispanic White	.78	.53–1.14	−1.28	NS

* *N*=773. *P* value determined by using multivariate logistic regression. CI: confidence interval, GCS: Glasgow coma score, ICU: intensive care unit, ISS: injury severity score, TBI: traumatic brain injury.

cause few practitioner discretionary decisions are made regarding the largely mandatory admissions for more severely injured children who are evaluated and treated by tightly coordinated medical and surgical teams. Therefore, any effect of race on decision-making with respect to disposition might become more apparent in the group of children who were less severely injured.

As shown in Table 4, injury severity continues to affect the probability of hospital and ICU admission in the group of less seriously injured children. However, even in this group where discretionary admissions may have occurred, neither hospital nor ICU admission appears related to race. However, those with public insurance are ≈50% more likely to be admitted to the hospital than those with private insurance (OR 1.54, 95% CI 1.06–2.23, *P*=.023).

DISCUSSION

We sought to understand the relationship of minority status to the severity, medical disposition, and mortality of pediatric TBI in a large series of patients from a single children's hospital that serves as a regional trauma center. These analyses were undertaken because of the relative paucity of information regarding both pediatric[10,14] and injury disparities.[15,16]

Table 4. Relationship of race/ethnicity to medical disposition among children with less serious TBI: result of a multivariate logistic regression (*N*=618)

	Odds Ratio	95% CI	Z	*P* value
Hospital admission				
Age	.98	.95–1.02	−0.95	NS
ISS	1.21	1.14–1.28	6.35	.000
Public insurance	1.54	1.06–2.23	2.27	.023
Non-Hispanic White	.99	.68–1.44	−0.04	NS
ICU admission				
Age	.92	.87–.97	−3.05	.002
ISS	1.36	1.25–1.49	6.78	.000
Public insurance	1.70	.98–2.95	1.98	NS
Non-Hispanic White	.69	.39–1.22	−1.28	NS

P value determined by using multivariate logistic regression. CI: confidence interval, ICU: intensive care unit, ISS: injury severity score, TBI: traumatic brain injury.

We found that minority children in this data set were no more likely to experience severe traumatic brain injury than non-Hispanic White children. Furthermore, both among children of all severity levels and those less seriously injured, neither medical disposition nor mortality differed by racial/ethnic group. These results are generally reassuring and suggest that in this institution-specific data set, no appreciable disparities exist. These findings may suggest approaches to decreasing disparities in other medical and surgical conditions. To yield this potential benefit, however, we must consider alternative explanations for the lack of disparities observed in our analyses.

First, outcomes described here may have been relatively insensitive, and a more granular appreciation of issues such as neurologic status at discharge or specific treatment modalities may reveal significant disparities. This type of analysis would, of course, require future research, as the trauma dataset we analyzed was limited.

Second, significant errors or biases may exist in the data set being analyzed, which would obscure any disparities. Arguing against this likelihood is the fact that several of our findings tend to validate the accuracy of the collected data. For example, as expected, we found that younger children were at increased risk of dying and that injury severity was strongly related to each of the outcomes evaluated.

Third, as demonstrated by the proportion of minority patients in this study, providers at this institution are experienced with high volumes of racial/ethnic minority cases that, in fact, constitute the majority of patients. Such familiarity may lead to increased cultural competence and decreased disparities.[17]

Fourth, ED evaluation and treatment of trauma generally, and TBI specifically, is delivered by a multiperson, multidisciplinary team, often in the highly visible environment of the trauma suite with standardized approaches. Furthermore, clinical decision-making is reviewed during conferences that are held regularly. Evidence-based standards for evaluation and treatment and frequent review may have reduced the variability that can lead to disparities.[18,19]

Fifth, this institution is a training site for surgical residents from a collaborating historically Black college, which increases the diversity of trauma response teams. A diversified and culturally competent medical workforce would likely be more capable of delivering equitable care to all patients.[20]

Finally, the ED at this institution has been involved in disparities research for several years, and disparities are a topic of concern to those directing the ED. Insofar as raising awareness is a step in recognizing and eliminating disparities, this history may have contributed to the findings described here.

Further focused research is required to identify and eliminate the unacceptable disparities that continue to adversely affect the health and well-being of many American citizens. In this context, identifying conditions in which evaluation and treatment appear to be free of disparities may provide insights for subsequent investigations and interventions.

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