Published in final edited form as:

J Am Coll Surg. 2013 August ; 217(2): 233–239. doi:10.1016/j.jamcollsurg.2013.02.032.

Health Disparities Analysis of Critically Ill Pediatric Trauma Patients in Milwaukee, Wisconsin

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Abstract

Background—Injury is the leading cause of childhood morbidity and mortality in the U.S. The associated costs exceed 20 billion dollars annually. This study examines disparities in disadvantaged populations of critically injured pediatric patients admitted to a level 1 pediatric trauma center.

Study Design—A retrospective study was conducted of all trauma patients admitted to the pediatric intensive care unit (PICU) at a level 1 pediatric trauma hospital from 2005–2009.

Results—Data on 324 patients were analyzed and 45% of patients were Caucasian, 33% African American 12% Hispanic and 10% other. There was no difference in age, Glasgow Coma Scale (GCS) or Injury Severity Score (ISS) across ethnic groups. The mortality rate was 12%. A higher percentage of Caucasians were commercially insured and from the highest income quartile than non-Caucasians ($p < 0.001$). African Americans had the highest rate of penetrating trauma and intentional injury compared to other ethnicities ($p < 0.001$). Nearly 75% of firearm injuries were clustered in 7 zip codes with the lowest median household incomes. The home was the most common location for firearm injuries. Children involved in assaults were more likely to have a single parent (67%) than two parents (26%, $p < 0.001$). Both ethnicity and payer status were significantly associated with mortality.

Conclusions—Significant disparities in socioeconomic status exist in severely injured pediatric patients treated in the PICU. These disparities were associated with adverse outcome. These results should inform community and public health efforts to identify the areas and populations at highest risk for violence related injuries.

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Disclosure Information: Nothing to disclose.

Presented at the American College of Surgeons 98th Annual Clinical Congress, Chicago, IL, October 2012.

Introduction

Pediatric injury accounts for approximately one third of all Emergency Department visits in the United States yearly. On average one in four American children are injured each year severely enough to require medical attention or restricted activity.¹ Based on 2010 data from the Centers for Disease Control (CDC), the death rate per 100,000 population in Wisconsin for individuals aged 18 or less was 12.9 for unintentional injury, 3.8 for intentional and 2.0 for firearm related injuries.² The total lifetime cost of injury for those 18 years of age or younger in the United States is 23 billion dollars for unintentional injury and over 2.5 billion dollars for intentional injury.³

A disproportionate number of injured children are from the lowest socioeconomic demographic.⁴ Minority race and low socioeconomic status (SES) have been shown to be associated with poorer outcomes.⁴⁻⁹ In addition, the prevalence of single parent families in the United States has risen dramatically over the last 40 years.¹⁰ In comparison to traditional two parent families, single parent families tend to have lower household incomes and children with higher rates of behavioral issues.^{11,12} The effect of single versus double parental guardianship on childhood injury is unknown.

This study examined critically injured pediatric trauma patients admitted to the pediatric intensive care unit (PICU) comparing mechanisms of injury, measures of SES such as demographics, guardianship (single vs. double parent guardianship), and the associated outcomes between ethnic groups.

Methods

A retrospective study was conducted to evaluate the association between socioeconomic status and ethnicity on outcomes in severely injured pediatric trauma patients admitted to the PICU. This study was performed at Children's Hospital of Wisconsin (CHW) after receiving institutional review board approval. CHW is an American College of Surgeons verified level 1 pediatric trauma center, one of two in the state. CHW receives trauma patients from throughout the state but due to its location in Milwaukee, a majority of patients are from the metro-Milwaukee area. Data were exported from the hospital's trauma registry and the VPICU Performance Systems (VPS) database. VPS is a clinical database for pediatric intensive care units that is externally audited to insure data integrity. All pediatric trauma patients (aged 18 or younger) admitted to the PICU from January 1, 2005 until December 31, 2009 were included.

Demographic and clinical data including age, gender, ethnicity, mechanism of injury, place of injury, PICU length of stay (LOS), mortality, Injury Severity Score (ISS), Glasgow Coma Scale (GCS), and operative procedures were exported from both the trauma database and VPS database. Payer status and guardianship were obtained from administrative data and chart review. Guardianship was categorized as either one or two individuals being guardians of the child. Guardianship data were obtained from social work consults, child advocacy consults and as reported at patient registration. Of the 324 patients, only one patient's guardianship status was unable to be identified.

Ethnicity was self-reported (African American, Caucasian, and Hispanic/other). Other races included Asian Americans, American Indians and Pacific Islanders, and mixed races. Payer status was categorized as commercial insurance, government insurance or uninsured. Patients were considered uninsured if their payer status was classified as cash or self-pay. Government insurance included Medicaid and Medicare.

Median household income was estimated based on each patient's home zip code matched to data from the 2000 U.S. Census.¹³ The patients were stratified into four median household income quartiles (<\$32,871, \$32,872-\$40,656, \$40,657-\$51,900, and \$51,901).

Statistical analyses were conducted using SAS 9.3 (SAS Inc., Cary, NC). Categorical variables were compared using a chi-square test. Continuous variables were analyzed with an ANOVA. ISS and GCS were categorized as ordinal variables with three groups each (ISS 1-14, 16-25, ISS>25 and GCS (13-15, 9-12, 3-8). Mild injury was considered as an ISS of 1-14 or GCS 13-15, moderate injury an ISS 16-25 or GCS 9-12, and severe injury an ISS>25 or GCS 3-8. The reference populations in the logistic regression models were Caucasian and commercially insured. Therefore the odds ratios reflect comparisons to these populations. P-values < 0.05 were considered statistically significant as were the confidence intervals of odds ratios that excluded 1.0.

RESULTS

There were 324 patients included in the analysis. As shown in Table 1, 45% were Caucasian, 33% African American, 12% Hispanic and 10% Other. The median age ranged from 10 to 11 years across ethnic groups and the majority of patients were males. There was no statistically significant difference in GCS or ISS categories across ethnic groups. The overall mortality rate was 12% (n=39).

A higher percentage of Caucasians were commercially insured (64%) and in the highest median household income category (46%) when compared to all other ethnicities (p<0.001). Mechanism and intent of injury varied by ethnicity. African American patients had the highest percentage of penetrating trauma (39%) and were more likely to be victims of assault (35%) as compared to all other ethnicities (p<0.001 for both) as shown in Tables 2 and 3.

Of the 47 firearm injuries, 79% occurred in African American patients, followed by 13% in Hispanic, and 4% in both Caucasians and the Other ethnic grouping (p<0.001). Seventy-two percent of the firearm related injuries occurred in Milwaukee County, within a cluster of seven inner city zip codes that are in the two lowest quartiles for median household income (Figure 1). Firearm injuries occurred most commonly in the home (40%) followed by on a street or highway (38%) with the rest occurring in other or unspecified locations (22%).

Severe head injury (GCS<9) was present in 92.3% of the 39 children that died in our study. Death from firearm related injuries accounted for 23% (n=9) of the overall mortality and all were in African American patients. Table 4 shows the association between parental guardianship and injury intent. Assault victims were more likely to have a single parent guardian (67%) as compared to unintentionally injured children who were more likely to

have two parental guardians (64%, $p < 0.001$). Similarly, 60% of patients injured by a firearm had a single parent guardian (data not shown).

The odds of mortality were highest in the Hispanic (OR 2.9, 95% CI 1.1-7.7 followed by African American (OR 2.0, 95% CI 0.90-4.4) ethnicities when compared to Caucasians (Table 5). The risk of mortality was 4.6 times higher in uninsured children (95% CI, 1.7-12.6) and 2.6 times higher in government insured children (95% CI, 1.1-6.2) when compared to those commercially insured. These differences were statistically significant.

Discussion

The study results suggest significant disparities between critically injured pediatric trauma patients treated at our institution. There is a wide chasm in socioeconomic status, as defined by median household income and insurance status, between Caucasians and non-Caucasian ethnicities. This discrepancy in SES is associated with increased assault rates and firearm related injuries in non-Caucasian patients. There was no statistically significant difference in age, gender, or injury severity across minorities; however there was a high percentage of penetrating trauma and firearm injuries in the African American patients. Although Hispanic children comprised only 12% of our study, they had the highest risk of mortality and highest percentage of uninsured patients (26%). Lastly, the increase in assaults and firearm injuries in children from single parent homes is noteworthy

Inferences from the results of these analyses are limited by the retrospective study design in a single institution. More precise information collected prospectively and across multiple institutions would increase the generalizability of the results. However, the results are consistent with larger national studies demonstrating wide disparities in pediatric trauma patients.¹⁴⁻¹⁶

Other studies have shown that uninsured and government insured patients are at increased risk of mortality when compared to commercially insured patients.^{6,14,15,17-21} It is hypothesized that uninsured and government insured patients might receive inferior, delayed or different care than insured patients, thus explaining their worse outcomes.^{14,17-20} However insurance status is also a proxy for other non-measurable confounders that affect mortality in critically injured pediatric patients.¹⁹

Non-Caucasian pediatric trauma patients had increased odds of mortality when compared to Caucasian patients. This disparity in mortality by ethnicity has been widely reported in nearly all facets of health care.^{4-6,14,16,19} One theory is that disparities may be associated with minorities seeking care at lower quality hospitals.¹⁴ This study refutes that hypothesis as our study reported a higher mortality rate in minority patients being cared for at a single level I pediatric trauma center. The disparities in outcome are multifactorial and likely related to low SES and mechanism of injury. The non-Caucasian patients were from a significantly lower SES (as measured by income and payer status) as compared to Caucasian patients. Low SES may have caused these patients to have a lower baseline health status (due to differences in health care access, rates of immunizations, nutrition, etc.) prior to injury, contributing to our findings.

An important finding is that 94% of firearm related injuries occurred within Milwaukee County with 72% occurring in seven of 29 city zip codes. Six of these seven zip codes are in the lowest household income quartile and the other being in the second to last. These results suggest a strong association between low SES and firearm injuries in Milwaukee. Tragically, nearly a quarter of all deaths in this study were caused by firearm injuries and all were in African American patients. Future public health, community and policing efforts should focus on these vulnerable populations and geographic areas.

The majority of firearm injuries in this study occurred in the home (40%). The presence of a firearm in the home is associated with an increased risk of unintentional shooting, suicide and homicide in pediatric populations. This risk is further increased when the firearm is a handgun.²²⁻²⁵ Nationally, it is estimated that a firearm is present in 35% of U.S. households with at least half of these being handguns.^{26,26} This estimate of firearm and handgun ownership is believed to be consistent in households with children.^{26,27} The prevalence of firearm ownership varies geographically and is highest in the South and Midwest and lowest in the Northeast.²⁸ Gun ownership in Wisconsin is one of the highest in the nation, with a 48% prevalence of firearm ownership and a 42% handgun ownership.²⁹ Of households in the U.S. with firearms, more than 33% are stored loaded, 50% unlocked and 22% both loaded and unlocked.^{27,30,31}

The American Academy of Pediatrics has a policy statement on firearms stating “the absence of guns from homes and communities is the most effective measure to prevent suicide, homicide, and intentional injuries to children and adolescents.”³² Although optimal, many families are reluctant to completely remove all firearms from their homes. Safe gun storage is the next most effective strategy in reducing firearm access and injury in homes with children and adolescents where guns are stored.³³ In an effort to reduce the firearm injuries in Milwaukee County, a safe gun storage campaign combining educational material and free gun locks or safes could be targeted at the seven most effected zip codes.

To our knowledge, this study is the first to examine the influence of parental guardianship on mechanism of pediatric trauma in the United States. Previous studies of British children reported those living in single parent homes had twice the risk of death by injury as compared to two parent households.^{34,35} In the United States, children aged 2-17 have been reported to demonstrate increased behavioral and conduct problems when living in single parent homes compared two parent homes.¹¹ Our data demonstrates a similar trend, as children who were intentionally injured (assault and firearms injuries) were more likely to live in a single parent home as compared to unintentionally injured children. Lack of parental support, financial resources, or oversight may also lead single parent children to engage in activities or be exposed to situations that make them more prone to intentional injury. Further research is needed to explore this theory.

Conclusions

Significant disparities in socioeconomic status exist amongst severely injured pediatric trauma patients treated at a level 1 pediatric trauma center. These disparities are associated with adverse outcome. The results suggest that injured children from single parent homes

are more likely to be victims of an assault than those from two parent homes and firearm injuries most commonly occurred in the home. These data should serve to direct community efforts and public health measures to the areas and populations most at risk for violence related injuries.

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Figure 1.

Youth firearm injuries and median household income in Milwaukee County by zip code tabulation area, 2005-2009. This map shows the zip code tabulation area where a firearm injury occurred in Milwaukee County among a pediatric population. Data sources: Case data is from the Children's Hospital of Wisconsin's trauma registry and VPICU Performance Systems (VPS) database. Both the median household income data (2000 US Census) and the ZCTA borders are from the US Census Bureau.

Table 1

General Patient Characteristics

	Caucasion	African American	Hispanic	Other	p Value
Total, n (%)	147 (45.4)	107 (33.0)	39 (12.0)	31 (9.6)	
Median age $\pm$ SD, y	10.3 $\pm$ 5.7	11.6 $\pm$ 6.0	10.4 $\pm$ 6.2	10.7 $\pm$ 6.1	0.38
Sex, male, n (%)	91 (62.0)	82 (76.6)	30 (76.9)	21 (67.7)	0.06
GCS, n (%) [*]					0.22
13 to 15	53 (36.5)	45 (42.1)	17 (43.6)	10 (34.5)	
9 to 12	14 (9.7)	20 (18.7)	4 (10.3)	3 (10.3)	
3 to 8	78 (53.8)	42 (39.2)	18 (46.1)	16 (55.2)	
ISS, n (%) [†]					0.88
1 to 14	47 (32.4)	38 (35.9)	16 (42.1)	8 (27.6)	
16 to 25	51 (35.2)	33 (31.1)	10 (26.3)	10 (34.5)	
26 to 75	47 (32.4)	35 (33.0)	12 (31.6)	11 (37.9)	
Insurance, n (%)					< 0.001
Commercial	94 (64.0)	16 (15.0)	10 (25.6)	14 (45.2)	
Government	41 (27.9)	73 (68.2)	19 (48.8)	13 (41.9)	
Uninsured	12 (8.1)	18 (16.8)	10 (25.6)	4 (12.9)	
Median household income quartile, n (%) [*]					<0.001
< \$32,871	4 (2.8)	56 (52.3)	16 (43.2)	5 (16.1)	
\$32,871-\$40,656	29 (20.0)	33 (30.8)	12 (32.4)	6 (19.4)	
\$40,657-\$51,900	45 (31.0)	16 (15.0)	7 (19.0)	11 (35.5)	
\$51,901	67 (46.2)	2 (1.9)	2 (5.4)	9 (29.0)	

^{*} 3 patients did not have GCS data.

[†] 6 patients did not have ISS data.

[‡] 4 patients did not have income data.

Table 2

Mechanism of Injury by Ethnicity

	Caucasian	African American	Hispanic	Other
Blunt, n (%)	132 (89.8)	56 (52.3)	29 (74.3)	29 (93.5)
Penetrating, n (%)	5 (3.4)	42 (39.3)	8 (20.5)	2 (6.5)
Suffocation, n (%)	3 (2.0)	1 (0.9)	1 (2.6)	0 (0.0)
Burns, n (%)	4 (2.7)	5 (4.7)	0 (0.0)	0 (0.0)
Other, n (%)	3 (2.1)	3 (2.8)	1 (2.6)	0 (0.0)

Table 3

Injury Intent by Ethnicity

	Caucasian	African American	Hispanic	Other
Assault, n (%)	8 (5.5)	38 (35.5)	9 (23.1)	6 (19.3)
Self Inflicted, n (%)	1 (0.7)	3 (2.8)	1 (2.6)	0 (0.0)
Unintentional, n (%)	137 (93.8)	63 (58.9)	29 (74.3)	25 (80.7)
Undetermined, n (%)	0 (0.0)	3 (2.8)	0 (0.0)	0 (0.0)

Table 4Guardianship by Injury Intent^{*}

	Assault [†]	Unintentional [*]	Self inflicted	Undetermined
Both parents, n (%)	16 (26.2)	162 (63.8)	1 (20.0)	0 (0.0)
Single parent, n (%)	41 (67.2)	88 (34.6)	3 (60.0)	2 (66.7)
Other, n (%)	3 (4.9)	4 (1.6)	1 (20.0)	1 (33.3)

* Guardianship not available for 1 patient; intent not available for 1 patient

p Value < 0.001 for assault compared to unintentional.

Table 5

Results of Univariate Logistic Regression for Mortality based on Race and Payer Status

	Odds Ratio	95% CI
Ethnicity		
Caucasian	Reference	
African American	2	0.90-4.4
Hispanic	2.9	1.1-7.7*
Other	1.2	0.32-4.6
Payer Status		
Commercial	Reference	
Government	2.6	1.1-6.2
Uninsured	4.6	1.7-12.6

*
p<0.001.