The American Journal of Surgery 213 (2017) 785–789

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

Firearm injuries in a pediatric population: African-American adolescents continue to carry the heavy burden

M. Bachier-Rodriguez, J. Freeman, A. Feliz*

Division of Pediatric Surgery, University of Tennessee, Health Science Center, Le Bonheur Children's Hospital, 51 North Dunlap, Suite 230, Memphis, TN, 38105, USA

ARTICLE INFO

Article history:
Received 25 August 2016
Received in revised form
8 October 2016
Accepted 10 October 2016

Keywords:
Pediatric trauma
Firearm injuries
Healthcare disparities
Adolescent

ABSTRACT

Background: Firearm injuries have the highest case-fatality rate among pediatric trauma related deaths. We sought to determine whether demographics, mechanism of injury, and outcomes were age specific.
Methods: We performed a 5 year retrospective analysis of patients 0–19 years old with firearm related injuries. Children were divided into two cohorts based on age. Mann-Whitney and Pearson's X^2 were used to compare continuous and categorical variables, respectively. Significance was established at $p < 0.05$.
Data: Compared to their younger counterparts, children >15 years old were more likely to be male (82% vs. 90%, $p = 0.02$), African-American (71% vs 89%, $p < 0.0001$), and injured due to assault (76.9% vs 44.6%, $p < 0.0001$). Mortality rates for children <14 was 1.4 times the national average (10.7% vs. 7.5%) while the rate for children >15 was 3.9 times the national average (12.4% vs. 3.2%).
Conclusion: Firearm injuries continue to be a prevalent public health concern greatly affecting African-American adolescent males. Prevention strategies and trauma related healthcare resource utilization should target this group in order to reduce the risk of injury and improve outcomes and case-fatality in our population.

1. Introduction

Data from the Center for Disease Control and Injury Prevention (CDC) show that homicide due to firearms is the 4th leading cause of death among children 1–14 years old and the 2nd leading cause of death in children 15–24 years old.[1] Reports from the National Trauma Data Bank 2014 Pediatric Report show that firearm injuries have the highest case-fatality rate among pediatric trauma-related deaths.[2]

Richardson et al. compared firearm death rates per 100,000 citizens in the United States and 23 other high-income countries. This study identified that, for youths 15–24 years old, the firearm homicide rate in the United States was 42.7 times higher than in the other countries. The same held true for suicide rates (8 times higher; children 5–14 years old) and unintentional firearm deaths (10 times higher; children 5–14 years old). In fact, among the 24 countries, 87% of all firearm deaths in children 0–14 years old were in the United States.[3]

On a national level, various studies have shown that states with weaker gun legislation and higher rates of household firearm ownership have higher homicides and suicide rates.[4,5] Tennessee's gun legislation is considered to be among the most permissive.[6] Violent crime rate per 100,000 citizens in our hospitals' county, Shelby, is 1,377, which is markedly elevated when compared to both the state (667), and the national benchmarks (386).[7] Age-adjusted death rate mapping provided by the CDC's Data and Statistics shows that Tennessee has a 2.50–3.07 firearm death rate per 100,000 children aged 0–19 years old.[8]

The public health concern associated to firearms is further scrutinized when one contemplates the economic burden generated by Emergency Department (ED) visits, hospital admissions and long-term disability secondary to non-fatal firearm injuries. Lee et al. examined the cost of firearm injuries in the United States and estimated an acute care cost of $6 billion dollars for patients treated in ED's in 2010.[9] In 2009, an average of 20 children and adolescents were hospitalized each day due to firearm injuries.[19] Other studies have documented that 50% of children with firearm injuries are discharged with a disability.[10–12]

Given the high prevalence and injury burden associated with firearm injuries in the pediatric population in west Tennessee, we

* Corresponding author.
E-mail address: afeliz@uthsc.edu (A. Feliz).

http://dx.doi.org/10.1016/j.amjsurg.2016.10.004
0002-9610/

sought to determine whether demographics, mechanism of injury, and outcomes were age specific.

2. Methods

2.1. Study design

Upon approval by our institutional Internal Review Board (IRB), we identified all children less than 20 years of age who were evaluated at Le Bonheur Children's Hospital, a Level 1 pediatric trauma center, and the Regional One Presley Trauma Center, a Level 1 adult trauma center, between 2009 and 2014 due to firearm injuries. Both trauma registry databases were queried to identify children with E Codes corresponding to penetrating injuries due to firearms (Table 1). Children with injuries due to non-powder guns were excluded from the cohort. Patients meeting inclusion criteria were then divided into two cohorts based on age at time of injury: 0–14 years old and 15–19 years old.

Data regarding demographics, mechanism of injury, extent of injury, emergency department disposition, and outcome were extracted. Mechanism of injury was determined according to E code classification and included unintentional injuries, assaults, suicide attempts, or undetermined (Table 1). Extent of injury was defined according to Injury Severity Score (ISS). ED disposition was defined as discharge home, admission to ward, admission to intermediate care unit, admission to intensive care unit, immediate transfer to an operating room, or death at the ED. Outcome data included measurements on overall length of stay, length of intensive care unit stay, and mortality.

We also queried the West Tennessee Medical Examiner for all children less than 20 years old who died due to firearm injuries between 2009 and 2014 in order to capture children that died at the scene and may not have been transferred to a hospital. Data from these patients are presented separately and are not included in the bivariate statistical analyses.

2.2. Statistical analysis

Bivariate analyses were performed to identify associations between the two age-dependent cohorts and demographic profile, mechanism of injury, extent of injury, injury distribution, ED disposition, and outcome data. Mann-Whitney and Pearson's χ^2 were used to compare continuous and categorical variables, respectively. A p-value < 0.05 was considered to be statistically significant. Statistical analyses were conducted using JMP ® Pro10 software (SAS Institute Inc., Cary, NC).

3. Results

There were 562 patients who suffered firearm injuries within the 5 year time frame; 20% (n = 112) were <14 years old, and 80% (n = 450) were between 15 and 19 years old. Compared to their younger counterparts, children >15 years old were more likely to be male (82% vs. 90%, $p = 0.02$), African-American (71% vs. 89%, $p < 0.0001$), and have sustained injuries due to assault (45% vs. 77%, $p < 0.0001$; Table 2). Assaults (45%) were the most common reason for injury in the younger age group followed by accidental incidents (41%). Over the study period, the annual incidence in GSW has increased in both groups (Fig. 1).

Interestingly, despite differences in gender, race and mechanism of injury, both age cohorts were similar regarding day and timing of arrival to ED. Fifty-one percent of younger children and 52% of adolescents sustained firearm injuries between Friday and Sunday (Fig. 2). Likewise, 70% of younger children and 76% of adolescents sustained firearm injuries between 4:00 p.m. and 4:00 a.m. (Fig. 3).

Regarding extent of injury and outcomes, adolescents were likely to be moderately to severely injured (ISS $\geq$ 9; $p < 0.0001$) and required more surgical interventions ($p = 0.0003$; Table 3). Mortality was not statistically different between study groups. Case-fatality rate for children $\leq$14 years old was greater than reported by the National Trauma Data Bank 2014 Pediatric Report (10.7% cohort vs. 7.5% national). Importantly, case-fatality rate for children $\geq$15 years old was four times higher than the national (12.4% cohort vs. 3.2% national).

To further analyze the differences in mortality rates, we evaluated the mortality rate for each year of the study period for each group. There was a peak in mortality for the 15–19 year olds in 2009 while the peak for the 0–14 year olds was in 2012 (Fig. 4).

There were 140 children less than 20 years old who were evaluated by the West Tennessee Medical Examiner during the study time frame. Of these, 49% (n = 68) were initially evaluated at our trauma centers, while 51% (n = 72) died in the pre-hospital setting. Due to the nature of the data, we cannot differentiate between patients seen in the ED and those that died in the field. Notwithstanding, it is important to note that of all patients evaluated by the Medical Examiner 94% were $\geq$15 years old, 88% were male, 90% were African-American, and 89% were the victims of assault.

4. Discussion

Our review of children who suffered firearm injuries found that the population cared for at our institutions consisted predominantly of African-American adolescent males. Our pediatric and adult trauma centers are located within the same campus and serve a large metropolitan area with a 52% African-American population.[13] As a result of our local population, 85.4% of the children who suffered firearm injuries were African-American, which is much higher than in the demographic findings of Leventhal et al.'s review of the 2009 Kids' Inpatient Database (KID). While African-Americans were still the dominant ethnicity effected by firearm injuries, they accounted for less than half (47.2%) of the study population.[19] Interestingly, when Safavi et al. examined the 2009 National Inpatient Sample (NIS) for firearm injuries, 78.0% of their population were white and only 22.0% African-American. However, their study population was much smaller with only 286 patients.[22]

Poorest median income neighborhoods have been identified as a predictive demographic factor for firearm injury.[20] The percentage of individuals below poverty level in Shelby county is 21.3%.[13] When looking at our service region, the range of percentages of individuals for below poverty level is 9.9% (DeSoto County, Mississippi) to 38.6% (Quitman County, Mississippi).[13]

Our data showed that while the mortality rate was similar between our study groups, the overall case-fatality rates in our patients were markedly greater than reported national rates for the same age groups and time frame (10.7% cohort vs. 7.5% national). Choi et al. reported an overall mortality of 5%, however their mean ISS was 4. In addition, only 17.3% of their patients required a trip to the operating room from the ED.[28] Our mean ISS was 12 with 42.7% requiring an immediate trip to the operating room, which is presumably the cause of the differential in the mortality rates.

Table 1
E code Classification of Mechanism of Injury.

E code	Mechanism of Injury
922.0, 922.1, 922.8, 922.9, 928.7, 928.9, 929.8	Unintentional
955.0, 955.1, 955.2, 955.4, 955.9	Suicide attempt
965.0, 965.1, 965.2, 965.3965.4, 965.8, 965.9, 969.0	Assault
985.0, 985.1, 985.2, 985.4, 989	Undetermined