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Degree and Date to be Conferred: PhD, 2018

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PUBLICATIONS

Hanish, S. I., Stein, D. M., Scalea, J. R., Essien, E., Thurman, P., Hutson, W. R., & ... Scalea, T. M. (2017). Molecular adsorbent recirculating system effectively replaces hepatic function in severe acute liver failure. *Annals of Surgery*, 266(4), 677-684.

Von Rueden, K. T., Wallizer, B., Thurman, P., McQuillan, K., Andrews, T., Merenda, J., & Son, H. (2017). Delirium in trauma patients: prevalence and predictors. *Critical Care Nurse*, 37(1), 40-48

Ginsberg, Z, Thurman, P, Scalea, T, & Stein, D (2016). Extracorporeal liver support for trauma-induced hepatic dysfunction. *Journal of Trauma & Acute Care Surgery*, 80(6), 1039-1044

Thurman, P, (2015). Clinical Nurse Specialist Regulation. *AACN Advanced Critical Care*, 26(1), 58-63

PROFESSIONAL ORGANIZATIONS

1996 – present American Association of Critical Care Nurses
Member of the Nominating Committee 2018 – current
Chair of the Advanced Practice Institute Planning Committee 2015 – 2016
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Reviewer of the AACN Bedside App Test Panel, 2013 – 2014
Reviewer for the Research Abstract Review Panel 2013 – 2014
Member of the Acute Care Clinical Nurse Specialist Scope and Standards Task Force, 2012 – 2013
Reviewer for the National Awards Program to Recognize Achievements in Eliminating Healthcare-Associated Infections, 2013
Reviewer for Evidence-Based Solutions and Research Abstracts, 2010 – 2011

1995 – present American Nurses Association

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ABSTRACT

Title of Dissertation: Firearm Injuries in Maryland, 2005-2014: Trends, Recidivism, and Costs

Paul A. Thurman, Doctor of Philosophy, 2018

Dissertation Directed by: Meg Johantgen, PhD, RN, Associate Dean for the PhD Program, OAD, Associate Professor, OSAH

Background: Violent injuries related to firearms are common in the U.S., whether accidental or intentional. Restrictions on use of Federal dollars for research on injury prevention involving firearms has limited our knowledge of how firearm injury impacts the health care system. The objectives of this study are to characterize firearm injuries (FI) in Maryland, quantify recidivism, and to describe hospital treatment and their associated costs for Maryland.

Methods: ED and inpatient hospital records utilizing E codes consistent with FI were linked across visits to create unique cases from 2005-2014. Recidivism was defined as any subsequent ED visit or hospitalization for FI. The relationship of social determinants of health derived from US Census data to the rate of FI hospitalization by zip code were examined with generalized linear models, as were FI associated hospital costs.

Results: Those with a FI are primarily single young black males, with overall hospitalizations decreasing over the time period. While 9% died in their initial FI, recidivism occurred in 3% of the individuals. Personal Disadvantaged (IRR = 1.13) and Working Disadvantaged (IRR = 1.04) factors were associated with increased rates of FI within zip codes. Hospital costs were significantly predicted by being self-pay/charitable and injury severity, with estimated mean costs for one FI of $47,364. In

2013, FI hospitalizations totaled $14m, of which 25% (n=129) accounted for over $10m.

Discussion and Implications: FI hospitalizations are decreasing and are increasingly linked to social determinants of health, which require multifaceted interventions with short term goals of interrupting ongoing violence and long-term goals of preventing future violence. The states are absorbing much of the health cost burden. Further research is needed, which should include developing a registry linking hospitalizations, deaths, and crime data that can be used to evaluate trends and effectiveness of interventions.

Firearm Injuries in Maryland, 2005-2014: Trends, Recidivism, and Costs

by
Paul Thurman

Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, Baltimore in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2018

To the Victims of Firearm Injury

and

Their Caregivers

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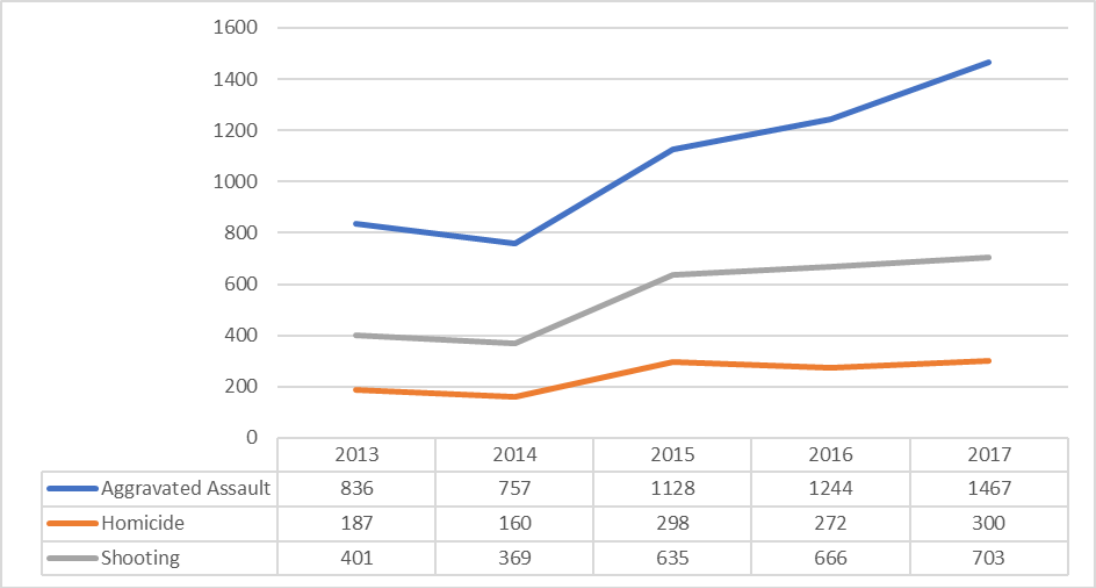
CHAPTER 1: INTRODUCTION

1.1 Background

Violent injuries related to firearms are common in the U.S., whether accidental or intentional. While it may seem that there has been an increase, of the annual 6 million victimizations, the percentage of all violence that involves a firearm did not change substantively between 2004 and 2011, fluctuating between 6% and 9%.[1,2] Yet, there is considerable variation by region with Baltimore City being known for violence. Between 2013 and 2017[3], on average Baltimore City had 555 shootings, 243 homicides involving a firearm, and 1086 aggravated assaults annually. Since 2014, those numbers have increased each year (Figure 1.1). Many of these injuries necessitate substantial acute and post-acute healthcare resources. Research quantifying the extent of the resources used, the short-term outcomes, and the repeated firearm injuries (FI) or recidivism is needed.



	2013	2014	2015	2016	2017
Aggravated Assault	836	757	1128	1244	1467
Homicide	187	160	298	272	300
Shooting	401	369	635	666	703

Figure 1.1 Baltimore City Firearm Crime Statistics 2013-2017

While crime data are collected on homicides and shootings, there are limited examination of their health implications. This statement, "none of the funds made available for injury prevention and control at the CDC may be used to advocate or promote gun control" was added to appropriations leading to a reduction in firearm injury (FI) research.[4] In January 2013, President Obama, through executive orders, directed federal agencies to improve basic knowledge related to: (1) causes of firearm violence; (2) interventions, which might be effective; and (3) strategies to minimize its public health burden.[4] President Trump's administration may be in support of firearm research as the Secretary of Health and Human Services Alex Azar stated that he would allow his department to conduct research into the causes of gun violence. Thus, there is an opportunity and a call to examine the costs and health outcomes of FI.

In considering the health resources required to treat FI, some information is known. In the US, most patients with FI are released home from the emergency department. Many are uninsured, resulting in considerable financial burden to hospitals, and federal, state and local government.[5-9]

Recidivism or recurrence of FI is poorly understood. Recidivism, a term borrowed from criminal justice literature, occurs in a person who has had a FI hospital admission and then has additional separate FI admissions that are unrelated to each other. For example, the individual has a FI to the leg, discharged from the hospital and then has a FI to the chest that occurs at a later date would exhibit recidivism. Recidivism may occur because of retaliation[10]. Being a victim of a shooting may prompt the victim to respond in kind, by engaging in violence to maintain their social standing, increasing their risk of re-injury[11]. In a study of hospitalizations from

Washington State, hazard ratios were calculated for risk of having a firearm related hospitalization, firearm related death, or being arrested for a firearm related or violent crime based on the reason for their initial hospitalization. For those whose initial hospitalization was for a FI, they had a significant hazard ratio of 21.2 for being hospitalized again for a FI, 4.3 for having a firearm related death, and 2.7 for being arrested for a firearm related or violent crime compared to those whose initial hospitalization was not related to any injury.[12]

The objectives of this study are to characterize the health care treatment and their associated costs for FI in Maryland, partially meeting two of the Institute of Medicine and National Research Council objectives: characterizing differences in nonfatal and fatal gun use across the United States (Maryland in this case), and improving the understanding of risk factors that influence the probability of firearm violence in specific high-risk physical locations. The long-term goal is to elucidate the factors associated with recidivism in FI. The central hypothesis is that recidivism in FI occurs disparately between racial/ ethnic groups, genders, ages, and socio-economic statuses with considerable societal costs for hospitals from unpaid charges and government through Medicaid programs.

The following specific aims will be examined:

1. Describe the FI characteristics and treatments of patients cared for in Maryland hospitals including extent of injuries, use of high cost hospitals resources (i.e. blood, intensive care, operations, etc.), and disposition.

2. Determine the frequency of recidivism for patients hospitalized for FI within a 10-year period and identify the individual and/ or neighborhood level characteristics associated with likelihood of recidivism versus no recidivism.

3. Estimate the acute care costs of firearm related injuries including hospital charges, length of stay, and disposition at discharge; determine the contributing factors associated with those costs.

1.2 Firearm Injuries Using Administrative Data

During research practicums and other course work in preparation for this dissertation and to better understand both emergency room data and state level variation in FI, data from the Healthcare Cost and Utilization Project's (HCUP) State Emergency Department Database (SEDD) for California in 2009 and data from the R Adams Cowley Shock Trauma Center Registry's data from 2000 – 2013 were examined. The SEDD dataset included 4977 records that were related to a FI using the International Statistical Classification of Disease (ICD-9) codes for external causes of injury. The sample was mostly male (87.3%), Hispanic (40.5%) and in the lowest quartile for median income (46.4%). Most of the sample was self-pay (47.6%). Most patients lived in urban areas with populations greater than 1 million people (68.4%). FI visits to the emergency department (ED) frequently occurred (40.7%) on the weekend. Months with the highest number of visits were May, June and July. Death occurred in 9.2% of this sample. Assaults were the cause for 52.6% of the visits, while the type of weapon used was mostly unspecified (73.8%). The mean age was 27.2 (SD 11.5). The mean ED cost per encounter is $2318 (SD $3638) using costs obtained from the CDC's Cost of Injury Reports. Thus, estimated costs for the ED encounters above were $10,744,978.

Given the large portion of payer status was self-pay in this sample, it is likely that some part of those costs will not be reimbursed or were paid for by Medicaid. This is type of injury affects mostly young adults, who may become disabled resulting in costs society in lost earnings and increased burden on the healthcare system.

The R Adams Cowley Shock Trauma Center Registry's data from 2000 – 2013 contains a total of 5,739 admissions that occurred from January 1, 2000 through December 31, 2013 from 5,601 unique patients with a FI.[13] In that time period, 5,511 patients had their initial firearm related injuries. The sample is 79.7% Black, 69.1% from Baltimore City and 90.5% male. Assaults accounted for 89.2% of the reason for injury and 92.3% of all injuries were the result of a handgun. The overall number of firearm related events ranged from 333 – 482 per year.

Recidivism (the second, third, or *n* event) in these data occurred 145 times in 135 patients. The data are left truncated in that eighty-five patients had their initial firearm related event prior to January 1, 2000 and, thus, time zero, the date of the first FI event, is unknown. The reason for injury in 96.6% of those with recidivism was assault and 95.9% were caused by a handgun. These events primarily occurred in Baltimore City (84.1%). When analyzed by stratified counting process with a stratified Cox proportional hazard model to control for the recurring event [14], those with recidivism have a hazard ratio of 6.5 (95% Confidence Interval 2.5-16.8) for death while controlling for the Injury Severity Score, compared to those that only have a single event. The Injury Severity Score was included in the model to control for the differences in the types of FI, such as superficial wounds to an extremity compared to a FI to the chest. After an initial FI, 81.2% survived to discharge from the hospital, after

the second event 78% of those survived, after the third event 67.9% of those survived, and after the fourth event 66.7% survived. Gender, race, reason for injury, type of weapon, nor living in Baltimore City significantly predicted recidivism when analyzed with generalized linear mixed models.

1.3 Significance

FI result in significant individual and societal burden and may be viewed as a public health disease. As mortality rates may be as high as 14%[15,16], these lives lost cause emotional loss to the individual's family and friends as well as loss of productivity that the individual may contribute to society as a whole as young people are primarily affected. Also, considering 75%of the victims meet full criteria for PTSD[17], if untreated they may develop mental illness and substance abuse further exacerbating symptoms. As up to 59% are discharged from the emergency department,[16] without appropriate follow-up, it may go unrecognized and untreated.

Treatment of firearm related injuries results in burden on the healthcare system in the use of resources, such as, hospital bed occupancy, operating room time, and blood use, without recoupment of payment in many cases related to lack of insurance coverage. This becomes problematic as many victims are evaluated in trauma centers associated with academic medical centers who may have limited funding due to their payor mix.

Poverty and low social determinants of health (limited education, unemployment, and environmental exposures) have been shown to be significant predictors of firearm related injuries, mainly affecting impoverished Black Americans. In the study of firearm related injuries, neighborhood level characteristics must be

considered to assess how social determinants of health independently influences the likelihood of FI.

Firearm related events are a significant challenge facing our nation. Given recent events, we need to determine the effects that community level characteristics play in the choices of individuals to carry a weapon and then to use that weapon. The impact of the Affordable Care Act (ACA) should be examined to determine if insurance coverage has any effect on hospital resources and revenue. The ACA may spur insurers to become involved in prevention programs for FI as they may begin to lose money by insuring high risk populations.

1.4 Research Questions and Hypotheses

Research question 1: What are the FI characteristics and treatments of Maryland residents cared for in Maryland hospitals including extent of injuries, use of high cost hospitals resources (e.g, blood, intensive care, operations, etc.), and disposition?

Hypothesis 1: It is hypothesized that FI occurs disparately in young, minority males.

Research Question 2: How do individual and/or social determinants of health change the likelihood of recidivism occurring?

Hypothesis 2: Social determinants of health, such as poverty will have a stronger prediction than individual characteristics of race in predicting one's likelihood for recidivism.

Research question 3: What factors contribute to the healthcare costs associated with FI?

Hypothesis 3: Costs associated with firearm related injuries will differ significantly based on the severity of the injury.

1.5 Research Design

No one data source was available that includes healthcare services for all firearm related injuries. Maryland collects information on inpatient services (as defined by Medicare) and hospital-based outpatient and emergency visits through the Health Services Cost Review Commission (HSCRC). As these yearly data are submitted by hospitals, they include all patients regardless of payor. These data were combined and linked to create a cohort of patients with FI and used to describe the characteristics of FI victims over a 10-year period, 2005-2015.

Then the administrative data were linked to other data sources.[18] The United States Census Bureau counts every resident and collects household level data to make estimates about income and poverty, housing, employment, education and family makeup in geographical areas such as zip code. These data were linked to the zip code of people with FI, providing data for social determinants of health.

Since individuals within the dataset have unique identifiers, recidivism could be identified within the dataset and records were linked to determine cases of recidivism. Both individual characteristics and social determinants of health were examined for their relationship to the odds of having recidivism and rates of FI using regression models. Hospital charges were converted to costs and examined for significant predictors while controlling for the severity of injury.

1.6 Conceptual Framework

Multiple theories for intentional acts of violence have been posited. The determinants of violence are thought to operate at multiple levels. These levels include the situation, individual, community, and society. In the *Great American City: Chicago and the Enduring Neighborhood Effect*[19], Sampson posits that these levels are all intertwined in a theory of context and that individual outcomes are not the simple result of their choices but reflect decisions that unfold within spatially grounded social structures and institutionalized processes that limit options, as well as reproduce existing inequalities between individuals, households, and neighborhoods. Human beings exist within well-defined social systems, such that individuals and their decisions are contextualized socially, spatially, and institutionally.

Characteristics of neighborhoods are highly stable over time despite movements of people and institutions into and out of specific areas. Inequalities between neighborhoods are determined by subjective perceptions connected to prejudices of race and class. Neighborhood resources reflect collective efficacy and organizational capacity, which are causes and consequences of individual and neighborhood characteristics. Collective efficacy has been defined as a shared expectation for social control. Both efficacy and capacity are connected to socioeconomic disadvantage and racial segregation. When efficacy and capacity weaken within the neighborhood, the neighborhood spirals into a perpetual decline. These have been shown to influence a variety of individual and aggregate outcomes including health, mortality and crime, all pertinent to the study of injuries related to violence.

In Sampson's theory of context (Figure 1.2), the outcomes of interest are rates of social behavior such as substance use, assaults, theft, etc. These outcomes are related to

the structure and culture of the neighborhood (link 4) and actions or "choices" of individuals (link 3). In link 4, the make-up of a neighborhood influences rates of social behavior for example ecologically concentrated disadvantage within a neighborhood has been linked to violence, disorder, and incarceration. Also, in link 3, the actions or "choices" of individuals, influence rates of social behavior such as choosing violence as a method of conflict resolution leads to violence, disorder, and incarceration. In link 2, the individual's action or choice can be determined by their propensity and capacity; perceptions and meanings; and/or interactions of these, such as an individual perceiving that someone disrespected them makes a decision to confront another leading to conflict resulting in violence. The culture of the neighborhood is such that all the person has is their self-respect. Culturally, self-respect is valued above anything else which leads to link 1. Sampson's theory of context provides a framework for multilevel modeling of environmental factors as well as individual factors in creating patterns of behavior. Using this theory, the social determinants of health: poverty, marital status, race/ ethnicity, education, vacant buildings, and employment, interact with the individual's characteristics: race, gender, age, alcohol/ substance use, and the severity of injury at their first FI, and influences whether they experience another FI (Figure 1.3). While this model is useful to study relationships, it is broad and difficult to use in supporting individual interventions. The theory of context is based on the city of Chicago, therefore, may not be generalizable to other cities, although Baltimore is much like Chicago in that they both have high rates of violent crime.

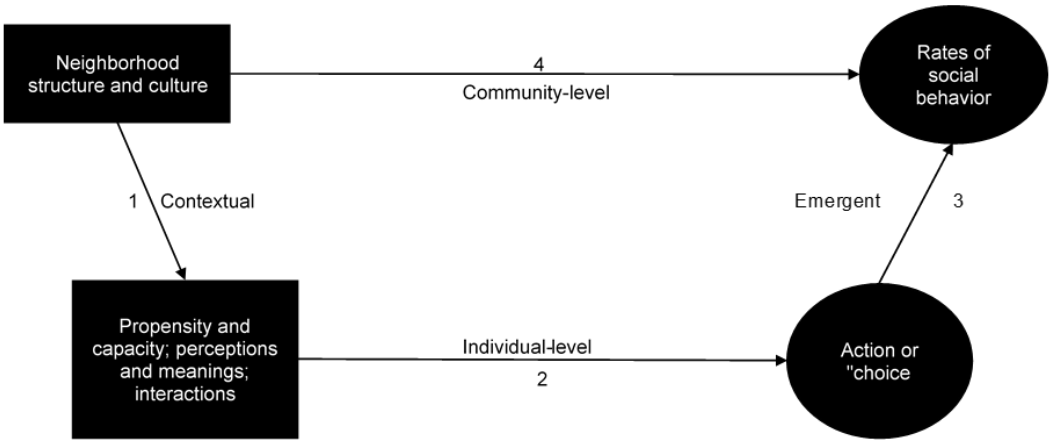


Figure 1.2. Sampson's Theory of Context

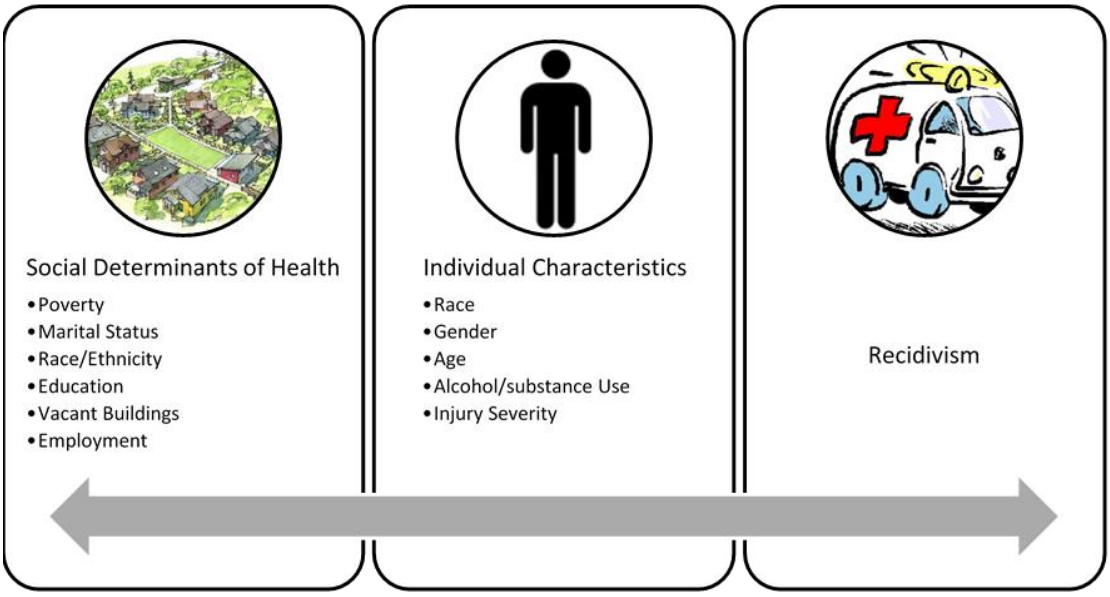


Figure 1.3. Relationship of Social Determinants of Health and Individual Characteristics to Recidivism in Firearm Injury

1.8 Assumptions, Limitations, Scope, and Human Subjects Protection

This study uses administrative data which are retrospective, thus causality cannot be inferred. Cases may be misclassified and bias the results as this administrative data rely on ICD-9 codes and hospital coding practices. Selection bias may result if the individual experienced a recurrent FI but died at the scene and never

made it to an ED. Information bias may occur as data are collected at many different hospitals with varying emphasis and effort at quality coding. The significant relationships found may also not be generalizable as they are specific to Maryland and the sample is primarily Black males. This study qualified for expedited review and was approved by the University of Maryland, Baltimore Institutional Review Board (Appendix A).

CHAPTER 2: REVIEW OF LITERATURE

This is a focused synthesis of FI in the United States highlighting characteristics that are related to this study. Details of individual studies may be found in Appendix B.

2.1 Introduction

Violent injuries related to firearms are a significant problem in urban areas. There has been a paucity in research since 1996 due a congressional amendment limiting CDC funding of FI research.[4] These injuries are expensive to treat. The victims are often uninsured and have significant social problems.[20]

According to the US Bureau of Justice, firearm violence accounted for about 70% of all homicides and less than 10% of all nonfatal violent crime from 1993 to 2011 with handguns being used for about 70% to 80% of firearm homicides and 90% of nonfatal firearm victimizations.[1] In 2013, about 75% of all serious violent crimes that involved a firearm were reported to police.[2] The number of injuries, their associated costs, and outcomes that may be related to these events is largely unknown. The literature was reviewed to determine the current gaps regarding firearm related injuries.

2.2. Methods

A literature search was conducted to determine what is currently known regarding firearm related injuries. Included in the search were "firearm" or "gun" and "injuries" which yielded 18,716 results. The search was narrowed by including United States of America, which lowered the count to 6,820. The search was limited to English language, peer reviewed academic journals lowering the count to 2,444. The search was additionally narrowed by selecting the following subject terms: research, epidemiology, mortality, research-finance, descriptive statistics, data analysis, logistic

regression, socioeconomic factors, statistics, cross-sectional method, correlational, public health, analysis of variance, longitudinal method, comparative studies, regression analysis, retrospective studies, disease prevalence and multivariate analysis, which yielded 314 results. After removal of duplicates 111 titles were reviewed. A total of 59 titles referred to either victim, injured or injury, incidence, prevalence, cost or charges, disparities, and/ or predictors, for full review. After full review 21 references remained for inclusion in this review.

2.3. Results

The details of each review can be found in Appendix B. The studies date from 1991 – 2017. The studies range from analysis of nationwide data sets to analysis of individual trauma registries to surveys of patients. The summary that follows is organized by demographics; intent of the FI; disposition; financial resources; injury types and surgical procedures; timing and location of occurrence; predictors of assault injury rate, homicide, mortality, FI and carrying a firearm; offender and victim relationship; post-traumatic stress disorder; and risk for a FI hospitalization, FI death, arrest based on firearm related or violent crime.

2.3.1. Demographics

Of those that have FI, between 80 and 92% were male. Between 55 and 86% were Black[6,21-25] and 14 and 24% were Hispanic[6,26]. The reported average age is 23 to 34 years[6,22], with 21% between the ages of 15-19 as well as 20-24 and 20% older than 40 years [9]. The amount of those at younger years has increased from 3.4% to 7.5% between the ages of 14-17[22], and 30% being younger than 25 years[22] and 50% being between the ages of 20-29 years[21].

2.3.2. Causes of Firearm Related Injuries

The total number of FI reported are between 131,013 to 134,445 annually[7,27] with total rates ranging from 38.5 – 70.32 per 100,000 persons[7,27,28]. Assaults are the leading cause of FI, accounting for between 52 – 78% of the firearm related injuries[7,9,16,25,28], suicide accounting for 7-8%[7,9], and unintentional intent (accidents) between 5-31%[9,16]. Handguns were the most reported weapon being used in 89-98% of cases.[16,21]

2.3.3. Disposition

Between 4 and 14%[15,16] of those with FI died prior to arrival at the hospital and overall mortality ranged from 4.7-14%[8,16,21,28]. Fifty nine percent of those seen in the emergency department were discharged home, while 35% required admission to the hospital.[16] Seventy-five percent of all firearm related injuries had a routine discharge home, 5% required home health services and 7% were discharged to a different type of facility.[9]

2.3.4. Financial Resources

The median hospital length of stay (LOS) is between 2.4 and 7 days[8,9,21,28], with critical care LOS[21] median of 3 days. The median time requiring mechanical ventilation is 1 day and the median units of blood transfused is 8 units.[21] Those who were injured were uninsured or had a self-pay payor status in 29 – 88% of cases.[5-9] Of the amounts payors and patients were charged, between 22 – 25% were recouped.[8,21]

Total annual charges ranged from $802,270,788 - $18,622,721,416 between 1994 and 2010.[5,7,9,21,27] One study[21] reported hospital charges increased by 323% from

2000-2011. The median charges for a patient requiring admission ranged between $4,423 and $17,000.

2.3.5. Types of Injuries and Surgical Procedures

FI most frequently impact the chest and abdomen causing an internal injury in 20% of cases, 16% of cases have a lower extremity fracture, 12% have an open wound to the head, neck, or trunk, and 12% have an open wound to their lower limb.[28] Seventy-five percent[21] require at least one surgical procedure with 71 – 80% requiring a procedure to their chest or abdomen[8]. Multiple procedures occur in 37% of patients[6] while 17% require no procedure[28].

2.3.6. Timing and Location of Occurrence

Peak occurrence occurs on Saturday into Sunday from 4pm – midnight in the months of October and November then again in January, May and June.[6,21,29] Trauma centers receive the majority of patients (82% of cases) and the events occur in the location of the patient's city of residence and within 6 miles of the trauma center.[21,26] FI events may cluster, as the occurrences of receiving 2 or more patients within 15 minutes of the other arrival has increased from 1-8% of the time in 2001 to 16-28% of the time in 2011.[15,21]

2.3.7. Predictors of Assault Injury Rate, Homicide, Mortality, FI, and Carrying a Firearm

FI assault injury rates have been associated with the percentage of vacant housing units and concentration of poverty.[26] Poverty, unemployment rate, lower proportions of adults older than 25 years of age, lower proportions of adults with high school or greater education have been associated with increased homicide rates.[22] FI is

9 times more likely to occur in males.[27] Being attacked at home, being Black, being male, being younger, perceiving the offender as being intoxicated, and being a Black male where a gun was used increased the likelihood of being injured in a violent event. However, being more "disadvantaged" and being a Black male, and having a gun used reduced the likelihood of being injured.[30] Adolescents from rural from Ohio were asked about their exposure to violence, 10% admitted they had a gun pointed at them and 8% stated they had been shot at. In these adolescents, their gender and amount of poverty significantly increased their likelihood of also carrying a gun.[31] Mortality from FI was associated with the number of units of blood transfused (OR=1.04), abbreviated injury scores for chest (OR=2.17) and head (OR=2.64), having multiple wounds (OR=1.11) and being of older age (1.03).[21]

2.3.8. Offender and Victim Relationship

The relationship of the offender to the victim varies by the gender of the victim. When the victim is a female, the offender was the current or former spouse in 15.9% of cases, the offender was a friend or acquaintance in 12.2% of cases, the offender was a stranger in 12.2% of cases, the offender was another family member in 5.8% of cases, the offender was part of a gang or group in 1.9% of cases, the offender was a parent or guardian in 1.6% of cases, and the offender was a police officer in 0.6% of cases.[26] When the victim was male, the offender was a stranger in 18% of cases, part of a gang or group in 12.6% of cases, friend or acquaintance in 9.9% of cases, police officer in 4.8% of cases, current or former spouse in 3.9% of cases, other family member in 3.7% of cases, and a parent or guardian in 1.6% of cases.[26]

2.3.9. Post-Traumatic Stress Disorder

In a group FI individuals who were followed up by a hospital violence intervention program, 75% met full criteria for having post-traumatic stress disorder (PTSD), with 81% meeting avoidance criteria, 91% meeting re-experiencing criteria, and 88% meeting arousal criteria. These patients in addition to their firearm event were asked about prior adverse childhood events.[17] Eighty-one percent had experienced 2 events, 50% experiencing 4 events, 22% experiencing 6 events, and 6% had experienced 8 or more events. These results underscore the need to integrate screening for PTSD and adverse childhood events into violence prevention activities—both in and beyond hospital settings.

2.3.10. Risk for a Firearm Related Hospitalization, Firearm Related Death, Arrest Based on Firearm Related or Violent Crime

In a study of hospitalizations from Washington State, hazard ratios were calculated for risk of having a firearm related hospitalization, firearm related death, or being arrested for a firearm related or violent crime based on the reason for their initial hospitalization.[12] For those whose initial hospitalization was for a FI, they had a significant hazard ratio of 21.2 (95% CI, 7.0 to 64.0) for being hospitalized again for a FI, 4.3 (CI, 1.3 to 14.1) for having a firearm related death, and 2.7 (CI, 2.0 to 3.5) for being arrested for a firearm related or violent crime compared to those whose initial hospitalization was not related to any injury

2.4. Discussion

Firearm related injuries result in significant individual and societal burden. Considering mortality rates up to 14%, these lives lost cause emotional loss to the

individual's family and friends as well as loss of productivity that individual may contribute to society as young people are primarily affected. Considering an estimated 75% of the victims could meet full criteria for PTSD and up to 59% of FI victims are discharged from the emergency department, without appropriate follow-up, PTSD may go unrecognized and untreated. Those with untreated PTSD may develop substance use disorder further exacerbating symptoms.

Treatment of firearm related injuries results in burden on the healthcare system in the use of resources, such as, hospital bed occupancy, operating room time, and blood use, without recoupment of payment in many cases related to lack of insurance coverage. As many of these patients are evaluated at trauma centers, usually located within an academic medical center with scarce resources, this becomes problematic given the make-up of their payor mix.

Considering Sampson's model, poverty and social capital (education, unemployment, and unoccupied residences) have been shown to be significant predictors of firearm related injuries, mainly affecting impoverished Black Americans. In the study of firearm related injuries, neighborhood level characteristics must be considered.

This review has many limitations given the studies may not be comparable. First, some studies are measured at the population level from large national data sets, while others are from individual hospital registries. The time frame also should be considered as dollar amounts in 1996 are not comparable to dollar amounts in 2011 without adjustment. Some studies may not be generalizable given the study of decision making to carry a gun may be different in rural Ohio than from an impoverished urban

area. Some firearm events may not be captured in these data sets when considering mortality and incidence, especially since the Bureau of Justice reports that only 75% of injuries are reported to the police.

This review demonstrated that firearm related events remain a significant challenge facing our nation. Given recent events, there is a need to determine the effects that community level characteristics play in the choices of individuals to carry a weapon and then to use that weapon. The model for weapon related behavior should be considered in determining any intervention points. The impact of the Affordable Care Act should be examined to determine if insurance coverage has any effect on resources and if that may spur insurers to become involved in reducing firearm related injuries.

CHAPTER 3: METHODS

This chapter presents the methods for this study including study design, data source, sampling design, measures and data analysis procedures.

3.1. Data sources

Currently no one data source is available that contains all firearm related injuries. According to the Bureau of Justice in 2013, about 75% of all serious violent crimes that involved a firearm were reported to police, thus crime statistics portray a partial picture.[2] The National Violent Death Reporting System is currently available for 32 states which links death certificates, coroner/ medical examiner reports, law enforcement reports and crime laboratories, which accounts for suicide and homicide, but not those that survive portraying a different picture. Healthcare data can provide a unique perspective.

Maryland collects information on all inpatient, hospital-based outpatient surgeries, clinic visits and referred outpatient ancillary utilization through the Health Services Cost Review Commission (HSCRC). The HSCRC dataset does not capture anyone who was seen in a private office or died at the scene of the injury portraying another view. The HSCRC has published annual reports on injury since 2002, which does include deaths from death certificates from the Maryland Vital Statistics Administration. The report for calendar year 2011 states there were 739 ED visits, 632 hospitalizations, and 496 deaths related to FI with total charges of $20,396,772.[32]

The HSCRC data were joined to data collected by the United States Census Bureau in the decennial census and the American Community Survey. These two data

sources are utilized since the US Census Bureau has changed how it collects information on the population. These two surveys account for every resident and collects household level data about income and poverty, housing, employment, education and family makeup. The data are aggregated to zip code which were linked to the zip code where the individual resides providing details about the social determinants of health for that individual.

3.2. Sample and Research File

Using ICD-9-CM E codes consistent with a FI, a dataset was compiled from 2005-2014 HSCRC data, which included a total of 8082 records. Each record represents a visit to a Maryland hospital, ED or inpatient. Of those records, 240 (3%) were missing zip code of residence, 62 (0.8%) were missing birthdate, 40 (0.5%) were missing race, 90 (1.1%) were missing payor, 4 (<.1%) were missing sex, and 214 (2.6%) were missing marital status. Not including marital status, a total of 436 (5.3%) records were missing key variables and were deleted from the dataset. Of the remaining 7,646 records, 720 (9%) records had a non-Maryland zip code and were excluded, leaving 6926 records for analysis. Each case was given a case code based on their numerical order in the dataset from oldest to newest.

Table 3.1 Coding of firearms in ICD-9-CM

	Handgun	Shotgun	Hunting rifle	Military firearm	Other	Unspecified
Accident	E922.0	E922.1*	E922.2	E922.3	E922.8	E922.9
Suicide or self-inflicted injury	E955.0	E955.1	E955.2	E955.3		E955.4
Assault	E965.0	E965.1	E965.2	E965.3		E965.4
Legal intervention	-	-	-	-	-	E970
Undetermined intent	E985.0	E985.1	E985.2	E985.3		E985.4
War	-	-	-	-	-	E991 (part)

Some studies have shown that combinations of few characteristics often uniquely or nearly uniquely identify some individuals in the population.[33,34] Almost 98% of the population in Montreal was uniquely identified by combining birthdate, gender, race, and zip code.[34] The dataset was examined for duplicate identifiers (ID), which included birthdate, gender, race, and zip code, to determine which records were from the same person. Multiple records with the same IDs may arise from patients being transferred from one facility to another, in which case the discharge date and admit date would be the same. They may also arise from readmissions related to the prior admission. The HSCRC dataset includes a variable for readmission, which occurs when a patient is discharged from a hospital and is admitted to any hospital within 30 days of the discharge. This variable was utilized to distinguish admission for a complication of FI from that of recidivism in those that had multiple records. The patient may also be admitted for a reconstructive surgery later such as a ventral hernia repair from an open abdomen, or colostomy reversal or because the patient was reinjured. They may also arise because two separate people may have the same gender, race, having the same birthdate, and zip code. Cases were sorted based on being a duplicate in order from oldest to newest based on discharge date. A variable was created for the time between the date of the admission for that record and the date of discharge of the immediately preceding record if the case was identified as a duplicate. Using this method, a total of 6544 primary records were identified and 382 duplicate records were identified. Each duplicate record was examined to ensure that the cases were indeed duplicates. These duplicate records were then given the same identifier as the primary case.

3.3. Measures

The measures used as outcomes and variables of interested are described below.

3.3.1. Recidivism

Recidivism is a term used mostly in the criminal justice system, referring to someone who is repeatedly incarcerated. Conceptually recidivism in this study occurs in a person who has had a FI hospital visit (ED and/or inpatient), is discharged and then has additional separate FI visit and they are both unrelated to each other. For example, the individual has a FI to the leg, discharged from the hospital and then has a FI to the chest that occurs later would exhibit recidivism. Operationally recidivism was identified using the unique identifier and the following criteria: 1) the time between the first case's discharge and the next case's admission was greater than 190 days; 2) the time was greater than 30 days and not classified by the HSCRC as a readmission as described above; 3) the time was greater than or equal to 14 days and hospital length of stay was less than 2 days; and 4) the time was greater than or equal to 7 days and hospital length of stay was less than 1 and the next admission was related to an assault. The time of 190 days was considered recidivism as most reconstructive surgeries had occurred by this time. The time of 30 days and not classified as a readmission was chosen because typically any complication of that injury would have occurred by then. The time of 14 days with a hospital length of stay was chosen to capture those patients who may have had a fracture, but didn't need to be admitted initially, but had a planned admission for repair within 2 weeks. This may occur during very busy times when the trauma center is at capacity and the injury is deemed to be urgent, but not in need of emergent repair. The time of equal to 7 or more days, hospital length of stay less than 1

day and the next hospital visit was labeled an assault was chosen to capture those cases that may be due to retaliation for instance, the individual is shot in gang activity, has a flesh wound which is treated and is discharged. The individual then finds the assailant exchanges gunfire and is re-injured.

3.3.2. Social Determinants of Health

Operationally, social determinants of health were measured at the zip code level (n=449). The selected measures for each zip code include percentage of Black residents; percentage of unemployment; percentage of those living below the poverty limit; percentage of those whose income is less than $25,000; percentage of those with schooling up to grade 12; percentage vacant housing; percentage of head of household obtaining public assistance; percentage of female head of household with children; and percentage of non-owner occupancy. The census percentages changed between 2000 and 2011 (Table 3.2). Cases from 2005 to 2010 were given the scores from the 2000 decennial census and cases from 2011 to 2014 were given the American Community Survey scores from 2011.

Table 3.2. Comparison of Social Determinants of Health, 2000 & 2011.

	2000	n=452					2011	n=460						
	Mean	SD	Median	IQR	Min	Max	Mean	SD	Median	IQR	Min	Max	Z	p
Female HH Child	6	4	5	4	0	21	6	5	6	6	0	38	-1.00	.319
Unemployed	3	3	2	2	0	30	5	3	4	3	0	30	11.50	<.001
HH Public Assist	2	2	1	2	0	16	2	3	1	2	0	26	-3.27	.001
Below Poverty	8	8	6	7	0	80	8	8	6	8	0	78	2.47	.014
Vacant	10	10	6	8	0	82	12	13	8	12	0	84	9.98	<.001
Non-Own Occupy	24	16	20	18	0	99	24	18	19	23	0	100	-2.69	.007
Black	16	20	9	18	0	97	16	23	7	20	0	95	-.72	.470
Grade12orLess	0	0	0	0	0	1	0	0	0	0	0	1	-14.24	<.001
25 K o r Less	0	0	0	0	0	1	0	0	0	0	0	1	-13.43	<.001

Many of these social determinants of health were highly correlated with each other in the FI sample data (Table 3.3), which could lead to multicollinearity. Percentage of head of household receiving public assistance had spearman's rho coefficients greater than .8 with the percentage of those living below the poverty limit, percentage of vacant housing, percentage of those with schooling up to grade 12, percentage of those earning $25,000 or less. The percentage of those living below the poverty level similarly had coefficients greater than .8 with percentage of vacant housing, percentage of those with schooling up to grade 12, percentage of those earning $25,000 or less. The percentage of those with schooling up to grade 12 had a coefficient greater than .8 with earning $25,000 or less. Factor Analysis was used to reduce the number of measures as these items are most likely a result of latent variables of social determinants of health such as economic inequality due to structural forms of racism.[35] Initially, using the census data from the joined data set, the variables mostly loaded onto a single factor except for the percentage of Blacks per zip code. The percentages were converted to standardized scores and averaged which was labeled "Disadvantaged" and used in the bivariate and multivariate model for recidivism using generalized estimating equations. As the analysis of social determinants of health was limited in their relationship to recidivism, they were modeled with the numbers of FI hospitalizations for black males. Again, factor analysis was utilized to determine the relationships to each other on the original census data at the zip code level because the number of zip codes represented differed between the analysis of recidivism and the analysis of all numbers of FI hospitalizations of black males for each zip code. The variables could be reduced to 3 factors with essentially 3 variables on each factor (Table

3.4) with Eigenvalues of 2.98, 1.35, and .95. The percentage of females with children as head of household, percentage of Black residents and percentage of non-owner-occupied housing loaded together and were named "Personal Disadvantage" factor (Eigenvalue =2.98). The percentage of unemployed, percentage with 12 grade education or less, and the percentage of those earning less than $25,000 loaded together and were named "Working Disadvantage" factor (Eigenvalue = 1.35). The percentage of vacant buildings, the percentage of those living below the poverty limit, and the percentage of residents who were the head of household and receiving public assistance hung together and were named "Poverty" factor (Eigenvalue = .95). The percentages of each item were transformed by binning to a scale of 0-100, thus the lowest percentage was recoded to zero and the highest percentage was recoded to 100. The mean of the three variables for each zip code created the score for each factor. The greater the score, the more disadvantaged the zip code may be on each factor. The lower the score, the less disadvantaged the zip code may have for each factor. This was utilized to examine their relationship to the number of FI hospitalizations for Black males.

Table 3.3. Correlations Between Social Determinants of Health (n=5876)

	1		2		3		4		5		6		7		8		9	
Female HH Child	1.00																	
Unemployed	0.69	**	1.00															
HH Public Assist	0.68	**	0.76	**	1.00													
Below Poverty	0.58	**	0.74	**	0.91	**	1.00											
Vacant	0.52	**	0.78	**	0.81	**	0.86	**	1.00									
Black	0.74	**	0.59	**	0.53	**	0.40	**	0.40	**	1.00							
Grade12orLess	0.58	**	0.59	**	0.89	**	0.85	**	0.70	**	0.37	**	1.00					
25K or Less	0.57	**	0.64	**	0.92	**	0.94	**	0.79	**	0.39	**	0.91	**	1.00			
50 to 25K	0.37	**	0.04	**	0.16	**	0.03	**	-0.02	**	0.26	**	0.27	**	0.16	**	1.00	
Non-Own Occupy	0.55	**	0.61	**	0.66	**	0.77	**	0.65	**	0.40	**	0.61	**	0.71	**	0.08	**

HH = Head of Household

Table 3.4. Factor Analysis of Social Determinants of Health (n=449)

	Factor Loadings		
	Personal	Working	Poverty
Female HH Child	.78		
Black	.76		
Non-Own Occupy	.68		
Unemployed		.80	
Grade12orLess		.70	
25K or Less		.66	.53
Vacant			.69
Below Poverty	..40	.49	.55
HH Public Assist	.36		.46
Eigenvalues	2.98	1.35	.95
Total Variance Explained	37.26	16.81	11.81

Description of the Factors for 2011 can be found in Table 3.5 and were joined to the aggregate of FI hospitalization counts and rates for Black males for each zip code. In each of the factors, as the measure increases, the amount of disadvantage increases. Rates of FI hospitalization for Black males by zip code were chosen as recidivists are primarily Black males.

Table 3.5. Description of the 3 Factors Associated with the Social Determinants of Health (n=457)

n=456	Mean	SD	Median	IQR	Minimum	Maximum
Personal Disadvantage	20	14	16	16	1	73
Working Disadvantage	17	9	15	11	2	73
Poverty	11	11	9	9	1	100

3.3.3. Costs

Conceptually costs are related to the money needed to restore a person to their prior level of functioning. Operationally this may be the total charges incurred during hospitalization. Hospital-level total inpatient costs are derived from inpatient charges using the HCUP cost-to-charge ratios. The group average cost to charge ratio

(GAPICC) is a weighted average for the hospitals in the group (defined by state, urban/rural, investor-owned/other, and number of beds), using the proportion of group beds as the weight for each hospital. The cost to charge ratios were obtained for 2005 and 2010. Eleven hospitals were included in 2005 and 9 hospitals in the 2010 HCUP charge to cost ratio datasets of which only 2 hospitals were included in both 2005 and 2010. There were no significant changes (t=.102, p=.92) in the ratios from 2005-2010. The mean cost to charge ratio of 0.77 for Maryland was used to adjust hospital charges to costs. The individual hospital codes were not available; therefore, the mean ratio was used.

3.3.4. Diagnoses and Procedures

Diagnoses and procedures are associated with costs incurred during the hospital care. To determine these associations dummy variables were created for the most common diagnoses and procedure ICD-9 codes. These can be found in Table 3.5 and 3.6.

Table 3.6. Diagnoses and Related ICD-9-CM codes

Diagnoses	ICD-9	Description			
Abdominal Injury	8793	Opn wnd ant abdomen-comp	Liver or Spenic Injury	86405	Liver lacerat unspcf cls
	8794	Opn wnd lateral abdomen		86412	Liver lacerat, minor-opn
	8795	Opn wnd lat abdomen-comp		86413	Liver lacerat, mod-open
	86813	Peritoneum injury-open		86414	Liver lacerat, major-opn
Arm Injury	8821	Opn wound hand-complicat		86415	Liver lacerat unspcf opn
	8840	Open wound arm mult/NOS		86510	Spleen injury NOS-open
	81231	Fx humerus shaft-open		86812	Biliary tract injury-opn
	88000	Open wound of shoulder	Lung Injury	8601	Traum pneumothorax-open
	88003	Open wound of upper arm		8603	Traum hemothorax-open
	88013	Open wnd upper arm-compl		8604	Traum pneumohemothor-cl
	88100	Open wound of forearm		8605	Traum pneumohemothor-opn
	88101	Open wound of elbow		86130	Lung injury NOS-open
	88102	Open wound of wrist		86131	Lung contusion-open
	88110	Open wound forearm-compl		86132	Lung laceration-open
Back Injury	8760	Open wound of back		86239	Intrathorac inj NEC-open
	8761	Open wound back-compl	Paraplegia	3441	Paraplegia NOS
	8770	Open wound of buttock	Retroperitoneal Injury	86610	Kidney injury NOS-open
	88001	Open wound of scapula		86612	Kidney laceration-open
Bowel Injury	86320	Small intest inj NOS-cl		86814	Retroperitoneum inj-open
	86331	Duodenum injury-open	Alcohol Use	30500	Alcohol abuse-unspec
	86339	Small intest inj NEC-opn		30501	Alcohol abuse-continuous
	86340	Colon injury NOS-closed	Drug Use	30401	Opioid dependence-contin
	86342	Transverse colon inj-cl		30520	Cannabis abuse-unspec
	86345	Rectum injury-closed		30521	Cannabis abuse-contin
	86350	Colon injury NOS-open		30522	Cannabis abuse-episodic
	86354	Sigmoid colon inj-open		30550	Opioid abuse-unspec
	86355	Rectum injury-open		30590	Drug abuse NEC-unspec
	86399	GI injury NEC-open	Tobacco Use	3051	Tobacco use disorder
Chest Injury	8621	Diaphragm injury-open			
	8750	Open wound of chest			
	8751	Open wound chest-compl			
Leg Injury	8900	Open wound of hip/thigh			
	8910	Open wnd knee/leg/ankle			
	8911	Open wnd knee/leg-compl			
	8940	Open wound of leg NEC			
	82111	Fx femur shaft-open			
	82310	Fx upper end tibia-open			
	82311	Fx upper end fibula-open			
	82332	Fx shaft tibia w fib-opn			

Table 3.7. Procedures and Related ICD-9- CM Codes

Procedure	ICD-9	Description
Antibiotics	9921	Inject antibiotic
Chest Tube Insertion	3404	Insert intercostal cath
Cardiopulmonary Resuscitation	9960	Cardiopulm resuscita NOS
Central Venous Catheterization	3893	Venous cath NEC
Enteral Nutrition	966	Entral infus nutrit sub
Endotracheal Intubation	9604	Insert endotracheal tube
Fasciotomy	8314	Fasciotomy
Mechanical Ventilation	9671	Cont inv mec ven <96 hrs
	9672	Cont inv mec ven 96+ hrs
Blood Transfusion	9904	Packed cell transfusion
Small Bowel Resection	4562	Part sm bowel resect NEC
Parenteral Nutrition	9915	Parent infus nutrit sub
Wound Care	8604	Other skin & subq i &
	8609	Skin & subq incision NEC
	8622	Exc wound debridement
	8628	Nonexcis debridement wnd
	8659	Skin closure NEC

3.3.5. Injury Severity

Injury occurs in various degrees and is induced by varying types of events. A flesh wound to the arm from a handgun represents a lesser degree of trauma than does an abdominal injury from a rifle, which in turn is less serious than a handgun injury that enters and exits the head. Controlling for severity of injury is necessary in making predictions of cost, mortality, and resource utilization. The Injury Severity Score (ISS) is derived from the Abbreviated Injury Scale (AIS).[36] The AIS is an anatomically based, consensus derived, global severity scoring system that classifies each injury by body region according to its relative importance on a 6-point ordinal scale (1=minor and 6=maximal).[37,38] The ISS is the result of squaring the three most severely injured body regions AIS score then adding together. Each injury is assigned an AIS score and is allocated to one of six body regions [Head, Face, Chest, Abdomen, Extremities

(including Pelvis), and External]. If there are multiple injuries in that body region, only the highest AIS score in each body region is used.[39] The ISS will be used to control for injury severity when making comparisons in mortality, cost, and length of stay. ISS tends to be not normally distributed and was recoded to a categorical variable where an ISS of 0-8 recoded as low, 9-14 as medium and 15 and above as severe.[40]

3.4. Analysis

For research question 1, a descriptive cross-sectional design was used to describe the characteristics of FI victims over a 10-year period. As this question is descriptive, a power analysis is not needed. Demographics, types of injuries, hospital resources and disposition were described using descriptive statistics. Mean and standard deviation were used to describe normally distributed continuous variables, median and percentiles were used for non-normally distributed variables, and percentages will be used to describe categorical variables. All statistical analysis was completed using IBM SPSS, v. 22.

For research question 2, a retrospective cohort design was utilized to examine an individual's risk for a recurrent FI and the relationship between individual and neighborhood level characteristics to the time of a recurrent injury. Cases of recidivism were identified over a 10-year period. Recidivism was reduced to a binary event, present or absent. The risk set was any individual who experienced a FI and did not die in the index ED or hospital visit. The individual was labeled as having recidivism if they experienced a recurrent FI as described above. Descriptive statistics were used for demographics of the groups. Bivariate analysis was completed to identify relationships

with the outcome as well as to identify relationships between the predictors. Logistic regression was utilized to explore the relationship of the predictors to having recidivism or not. Also, of interest was the effect of social determinants of health on the odds of having recidivism. This analysis attempted to utilize a multi-level model at the patient and zip code level. This sample contains 5,928 individuals in 301 zip codes with 172 identified cases of recidivism in 43 zip codes, which should have been adequate for 10 predictors. Neighborhood level characteristics were introduced as covariates requiring the use of generalized linear mixed models with a binary logistic regression. The Hessian matrix was not positive definite with generalized linear mixed models; therefore, generalized estimating equations was utilized. These models overfit due to the small number of cases in categories of the predictors as evidenced by small R square values and 100% prediction in the contingency table.

The likelihood of being a recidivist was regressed upon age using a conditional logistic regression model of matched pairs of FI hospitalization of non-recidivists (controls) and recidivists (cases) accounting for the lack of variation in the sample. These controls were randomly selected and exactly matched with the recidivist's race, sex, zip code, payor status, and intent of the FI to determine the ages of those who are at risk for recidivism. This methodology prevented the evaluation of social determinants of health on recidivism as the recidivists were matched to non-recidivists using zip code.

Black males comprise 83% of non-recidivists and 98% of the recidivist. The counts of FI hospitalizations for Black males by zip code were examined in relation to the social determinants of health. The FI hospitalization rates for Black males were

calculated using the total number of FI hospitalizations for Black males in a zip code divided by the total number of Black males for each zip code using the 2011 American Community Survey multiplied by 1000. This calculation yields the number of FI hospitalizations per 1000 Black males for each zip code. These rates were mapped using ArcGIS 10.6.1 using a point density map where 1 point represents 1 FI hospitalization per 1000 Black males for Maryland with the county overlay. To understand the relationship of social determinants of health to FI hospitalizations of black males, the 3 factors, "Personal Disadvantage", "Employment Disadvantage", and "Poverty" were used as predictors for the counts of FI hospitalizations for Black Males by zip code using a generalized linear model with a negative binomial distribution.

For research question 3, hospitalizations from 2013 were used. The data file was restructured and the costs of the 542 FI hospitalizations were summed to a single patient level unless the admission was unrelated to the prior injury which yielded 516 cases. This accounts for the few numbers of unique individuals that had more than one record due to transfers to higher levels of care and readmissions that were related to the same injury. This analysis was kept to a single year since dollar amounts are not comparable over the 10 year time span due to inflation. As this is a single level regression, the 516 cases were adequate for up to 35 predictors. Descriptive statistics were used for total costs for FI. Costs tend to be distributed in a negative binomial, Poisson, or gamma distribution. Options for dealing with skewed data are to transform the outcome or to fit a model using the distribution of the data. A fundamental assumption for the Poisson model is that the mean is equal to the variance. This assumption is often untenable. Consequently, the negative binomial distribution where

the variance exceeds the mean or gamma distribution where the variance is proportional to the square of the mean may be the preferred models. A modified Park test[41,42], utilized the residuals from a null regression model predicting costs to determine the best distribution for the data. To perform the Park test, the costs were log transformed and regressed upon the square of the residuals from a null model of costs with a resulting coefficient of 2.041. This indicates that the variance is proportional to the square of the mean; therefore, a gamma distribution would best fit the data. Crude estimates were obtained for adjusted healthcare dollars using bivariate models for predictor variables such as payer status, severity of injury, and other individual characteristics. Generalized linear models were used to adjust for covariates as they don't require normality and evaluates the log to the mean, not the mean of the logs limiting bias related to retransformation. The estimates obtained using the gamma distribution multivariate model were compared to those from linear regression model using log transformed costs.

CHAPTER 4: RESULTS

This chapter presents the findings of the FI hospitalizations, which includes ED and hospital visits for Maryland residents hospitalized in Maryland hospitals. The results are presented in order of research questions. First research question 1 describes the 10 years of FI hospitalizations and their trends. Following are the results from research question 2 regarding the analysis of recidivism. Finally, the results of research question 3 regarding hospital costs and their predictors are provided.

4.1. Characteristics of FI Hospitalizations of Marylanders

Between January 1, 2005 and December 31, 2014, 6926 hospitalizations for Marylanders occurred due to a FI. The demographics for FI hospitalizations (Table 4.1) are primarily young (median age 25 years old) males (92%), Black (83.4%), and single (86.6%), with Medicaid (47.7%). Nearly half of injuries (43.8%), were of low severity. Of the total number, 644 (9.3%) resulted in death. The majority, (67.8%) of FI hospitalizations are the result of an assault, with the weapon unspecified (68.1%). The median FI hospitalization cost was $9,676 and ranged from $15 to $2,157,227. The most frequent diagnosis codes were related to an injury to the leg (21%) and the most frequent procedure was blood transfusion (20.1%). Of the FI hospitalizations, 24.7% had a diagnosis code for tobacco use, 15.6% for substance use, and 9.2% for alcohol use.

Percentage of total hospitalizations as a percentage of the 10-year total decreased between 2006 and 2014 (Figure 4.1). As the number of FI hospitalizations decrease, so do total annual hospital costs. Although the annual frequency of hospitalizations has decreased, the proportion of fatal and non-fatal FI hospitalizations,

the intent of injury, and the weapon used has remained fairly constant (Figure 4.2, 4.3, & 4.4). The dataset contained no records of fatalities for 2013. The individual's age at time of hospitalization is younger for Blacks (median age = 24) than Whites (median age = 33) and other (median age = 28) races (Kruskal-Wallis df=2, 170, p<.001). The age at which the number of hospitalizations begins to increase for Blacks is 14 and peaks at 19 (Figure 4.5).

FI hospitalizations peak in July and nadir in February (Figure 4.6). Baltimore City residents had the highest proportion (56.2%) of the 6926 hospitalizations, followed by Prince George's County (14.6%), and then Baltimore County (11.3%) (Tables 4.2 and 4.3). Figure 4.7 depicts the proportion of total FI hospitalizations for the top 3 counties over the 10 years, showing the proportion of FI hospitalizations decreased for Baltimore City and Prince Georges county, while Baltimore County remained constant.

Table 4.1 Demographics of FI Hospitalizations, 2005-2014 (n=6926) Continued to the top of page 40

		Frequency	Percent
Sex	Male	6370	92.0
	Female	556	8.0
Race	Black	5773	83.4
	White	889	12.8
	Other	264	3.8
Marital Status	Single	5997	86.6
	Married	539	7.8
	Separated/ Divorced/ Widowed	176	2.5
	Missing	214	3.1
Payor	Private Insurance	1344	19.4
	Medicaid	3304	47.7
	Medicare	229	3.3
	Self-Pay/Charity	2049	29.6
Type of Event	Accident	1428	20.6
	Assault	4698	67.8
	Legal Intervention	87	1.3
	Self-Inflicted	281	4.1

		Frequency	Percent
	Unspecified	432	6.2
Weapon Used	Handgun	1904	27.5
	Shotgun	256	3.7
	Hunting Rifle	43	.6
	Military Firearm	5	.1
	Unspecified	4718	68.1
Injury Severity Score	No injury to Low (0-8)	3035	43.8
	Medium (9-14)	2205	31.8
	High (15 and above)	1686	24.3
Diagnoses	Injury to leg	1454	21.0
	Injury to lung	1099	15.9
	Injury to Arm	743	10.7
	Injury to chest	693	10.0
	Injury to back	617	8.9
	Injury to bowel	589	8.5
	Injury to the Abdomen	582	8.4
	Injury to liver or spleen	503	7.3
	Injury to retroperitoneum	339	4.9
	Paraplegia	127	1.8
Substance Use	Tobacco Use	1710	24.7
	Substance Use	1080	15.6
	Alcohol Use	637	9.2
Procedures	Blood Transfusion	1393	20.1
	Mechanical Ventilation	1377	19.9
	Wound Care	1044	15.1
	Central Venous Catheter	849	12.3
	Chest Tube Placement	842	12.2
	Antibiotics	409	5.9
	Small Bowel Resection	326	4.7
	Enteral Nutrition	263	3.8
	CPR	193	2.8
	Fasciotomy	170	2.5
	Total Parenteral Nutrition	131	1.9

	Mean	SD	Median	IQR	Minimum	Maximum
Age	29	12	25	13	1	95
ISS	11	12	9	13	0	99
Hospital Length of Stay	6	10	2	6	0	161
Cost	$25,019	$53,916	$9,676	$21,372	$15	$2,157,227

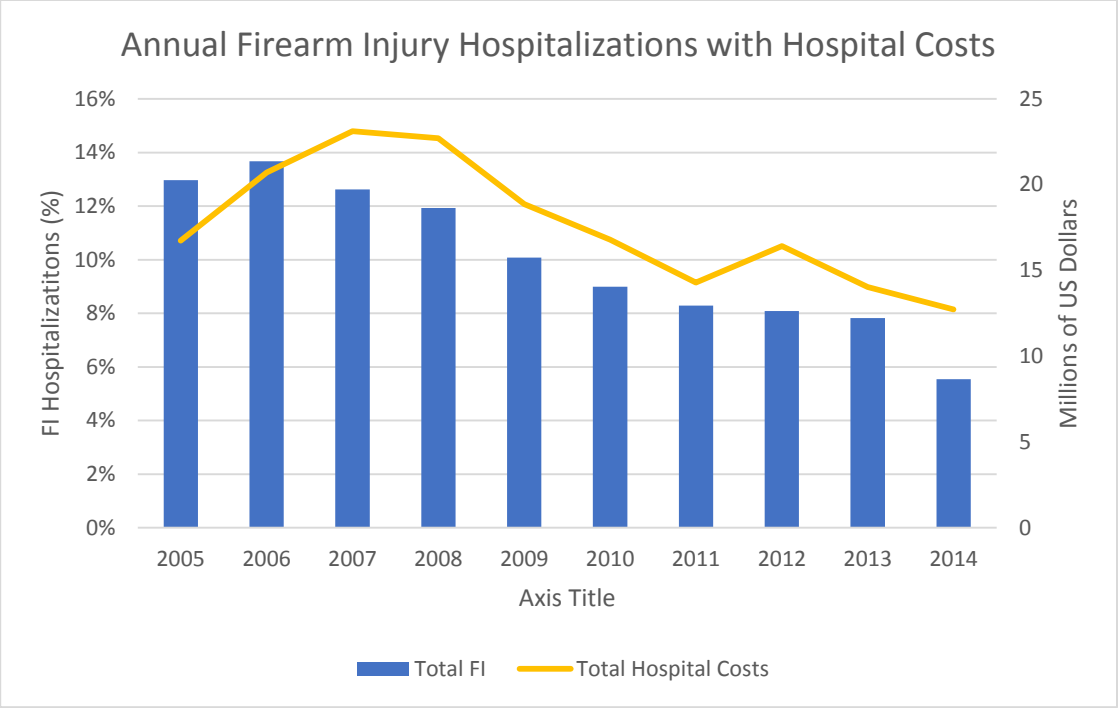


Figure 4.1.. Annual FI hospitalizations and total annual Hospital Costs, 2005-2014 (n=6926)

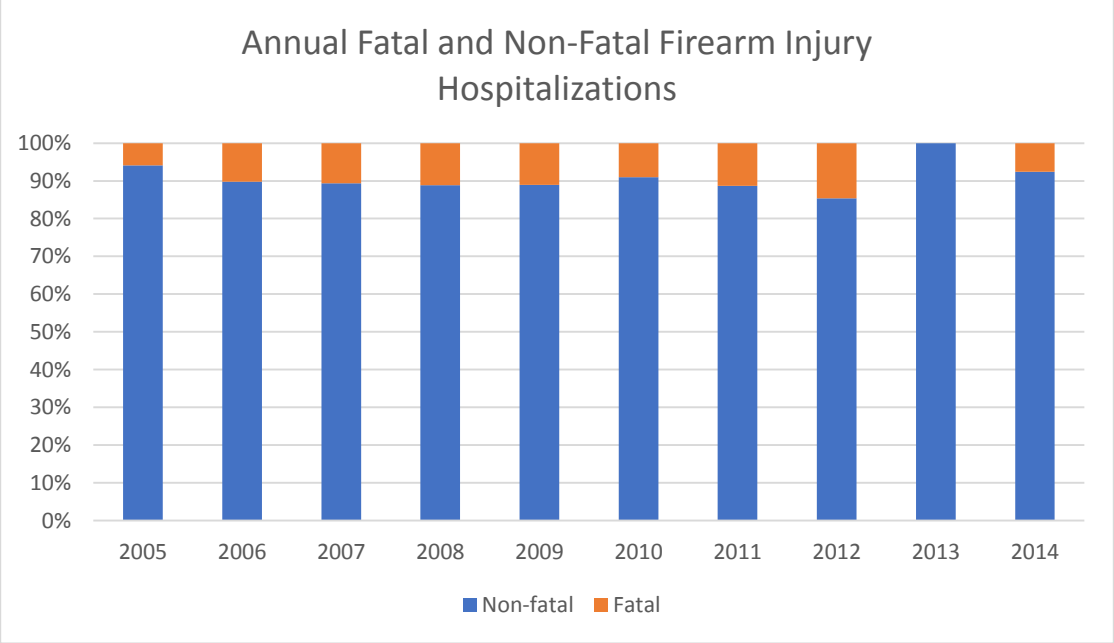


Figure 4.2. Annual Fatal and Non-Fatal Firearm Injury Hospitalizations, 2005-2014

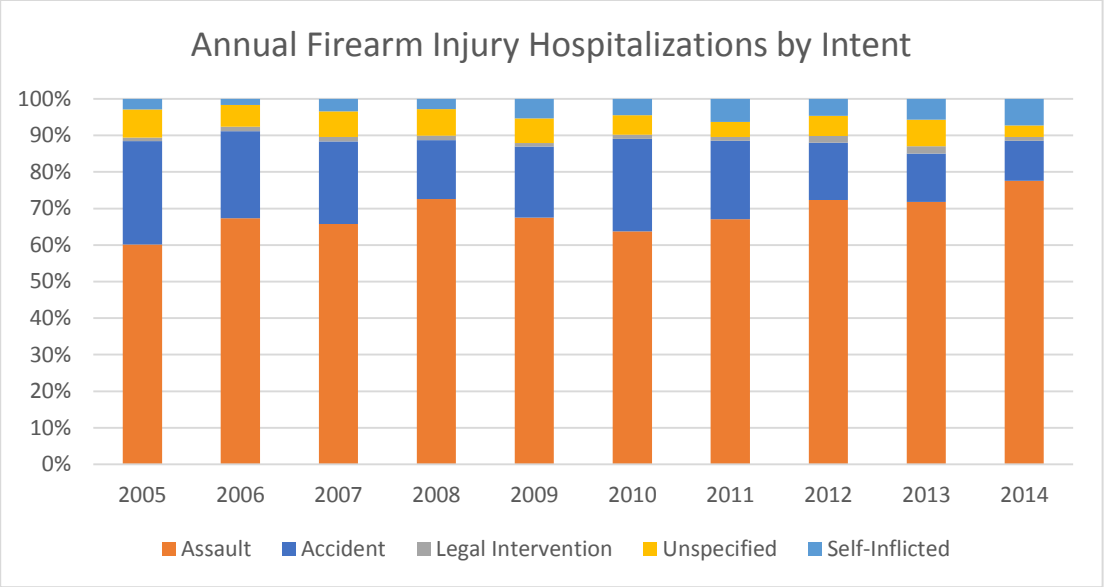


Figure 4.3. Intent by the total number of FI hospitalizations, 2005-2014

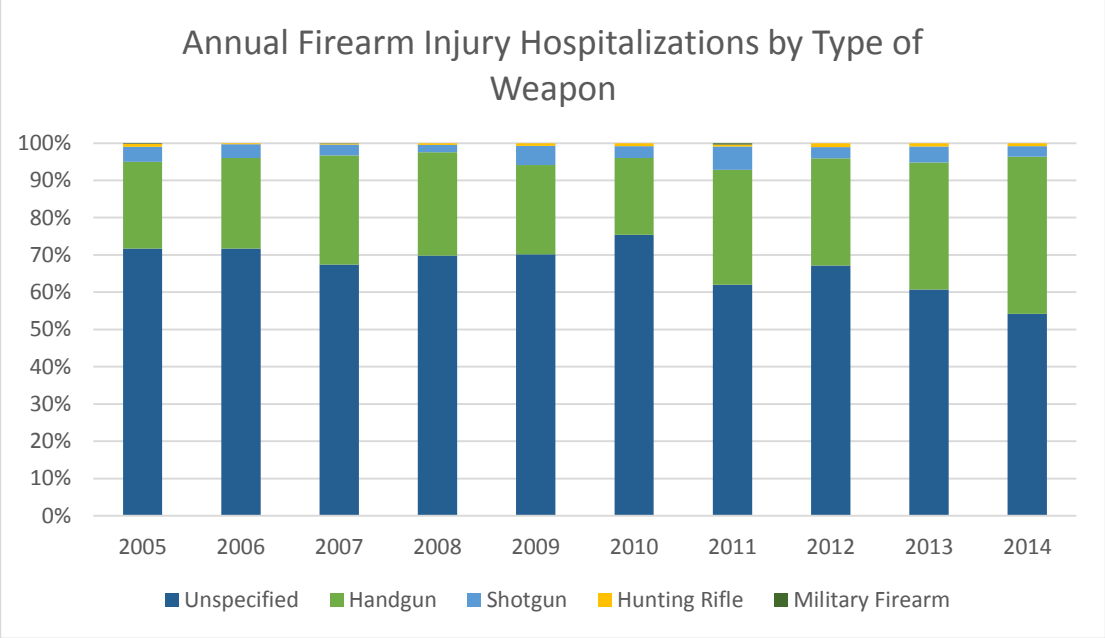


Figure 4.4. Weapon Used in FI Hospitalization, 2005-2014

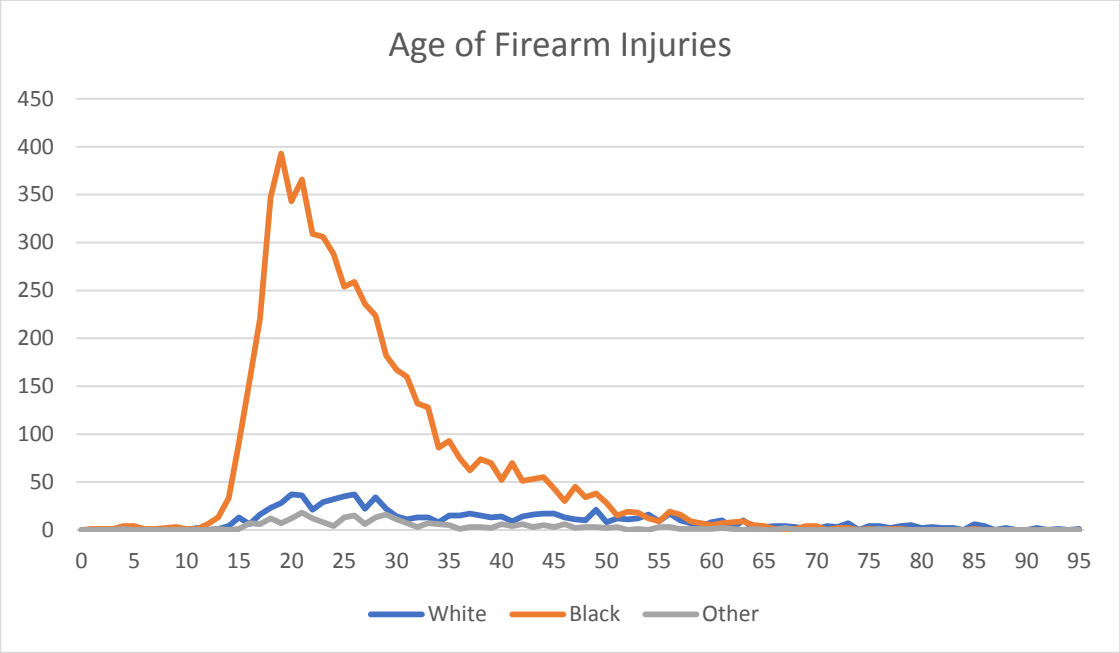


Figure 4.5. Number of FI Hospitalizations by Age and Race

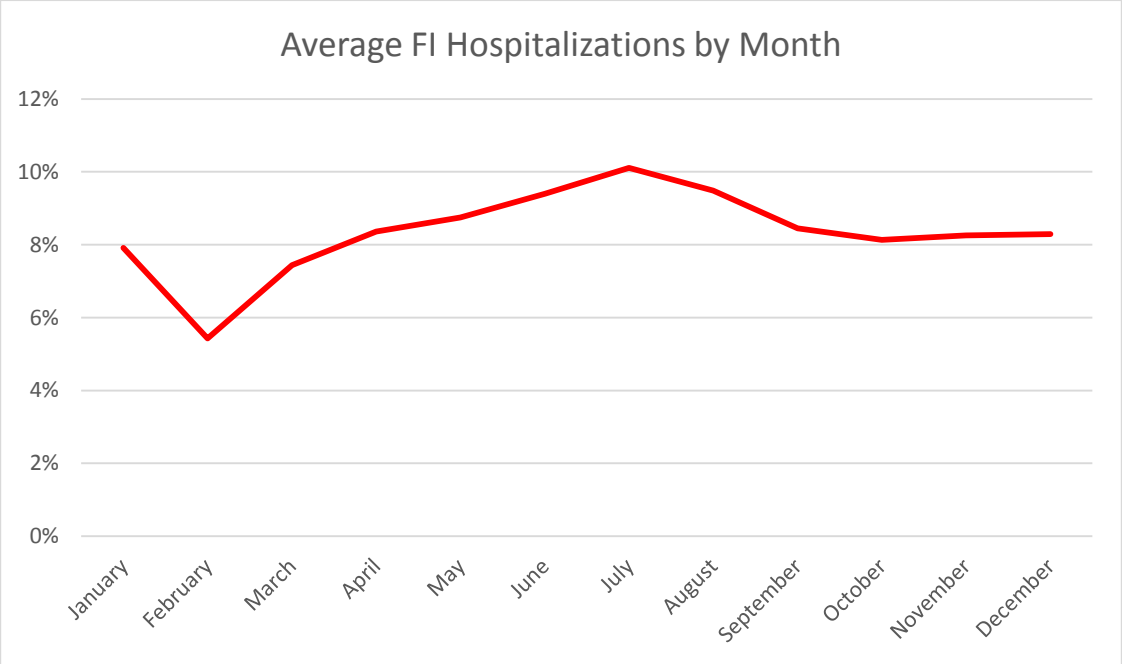


Figure 4.6. Average FI Hospitalizations by Month, 2005-2014

Table 4.2 Top 10 Maryland Cities of Residents with FI Hospitalizations, 2005-2014 (n=6926)

City	Frequency	Percent
Baltimore MD	3729	54
Hyattsville MD	225	3
Brooklyn MD	180	3
Capitol Heights MD	162	2
Gwynn Oak MD	148	2
District Heights MD	95	1
Salisbury MD	90	1
Upper Marlboro MD	86	1
Windsor Mill MD	84	1
Silver Spring MD	77	1

Table 4.3 Number of FI Hospitalizations by Resident's County, 2005-2014 (n=6926)

County	Frequency	Percent
Baltimore city	3891	56.18
Prince George's County	1014	14.64
Baltimore County	779	11.25
Anne Arundel County	290	4.19
Montgomery County	160	2.31
Harford County	113	1.63
Wicomico County	109	1.57
Frederick County	84	1.21
Howard County	84	1.21
Charles County	61	0.88
Washington County	56	0.81
Carroll County	46	0.66
Dorchester County	41	0.59
Cecil County	27	0.39
Allegany County	23	0.33
Worcester County	23	0.33
St. Mary's County	22	0.32
Somerset County	20	0.29
Talbot County	19	0.27
Calvert County	18	0.26
Kent County	16	0.23
Caroline County	15	0.22
Queen Anne's County	13	0.19
Garrett County	2	0.03

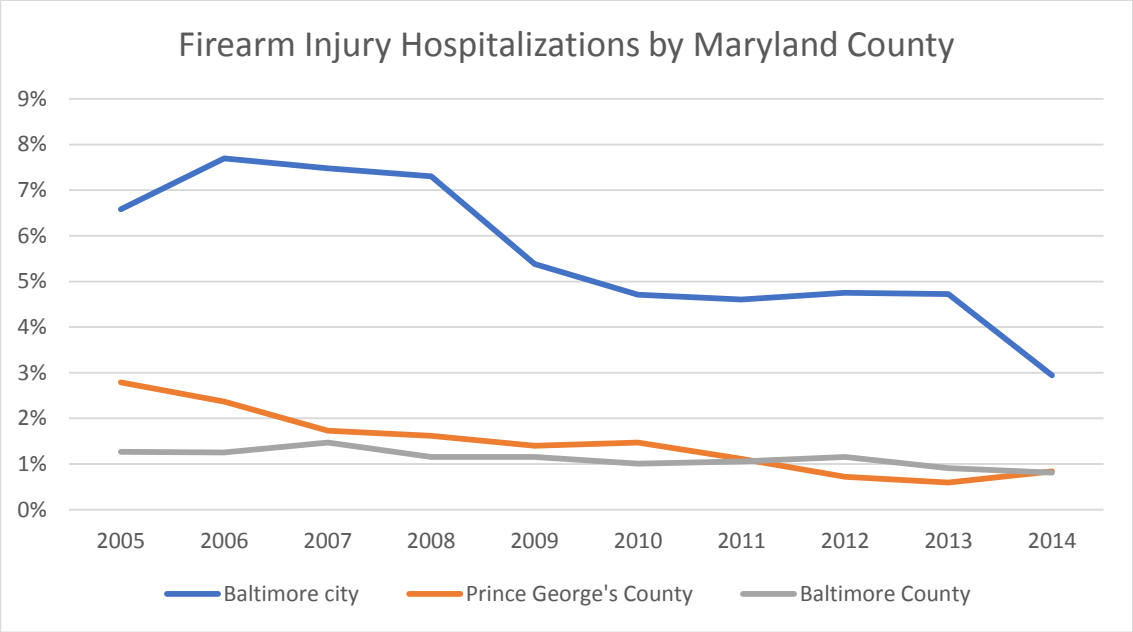


Figure 4.7. Percentage of Total FI Hospitalizations for Top 3 Maryland Counties

4.2. Recidivism

Using birthdate, gender, race and zip code, the 6926 hospital admissions between 2005-2014 were linked and represented 6,544 unique individuals. Of those individuals, 616 (9%) individuals died on their initial FI hospitalization, leaving 5,928 individuals at risk for recidivism. Of the 5,928 remaining individuals who have had at least one FI hospitalizations, 173 (3%) experienced recidivism of which 21 (12%) of those individuals died in the hospitalization for any of the subsequent FI. This number may be low given left truncation in 2005 and 2006 as well as right censored in 2013 and 2014 given the median time between index and the subsequent FI hospitalizations is 507 days. The peak age for recidivists at their initial FI hospitalization is 17 and the age of their recidivism FI hospitalization peaks at age 19 (Figure 4.8).

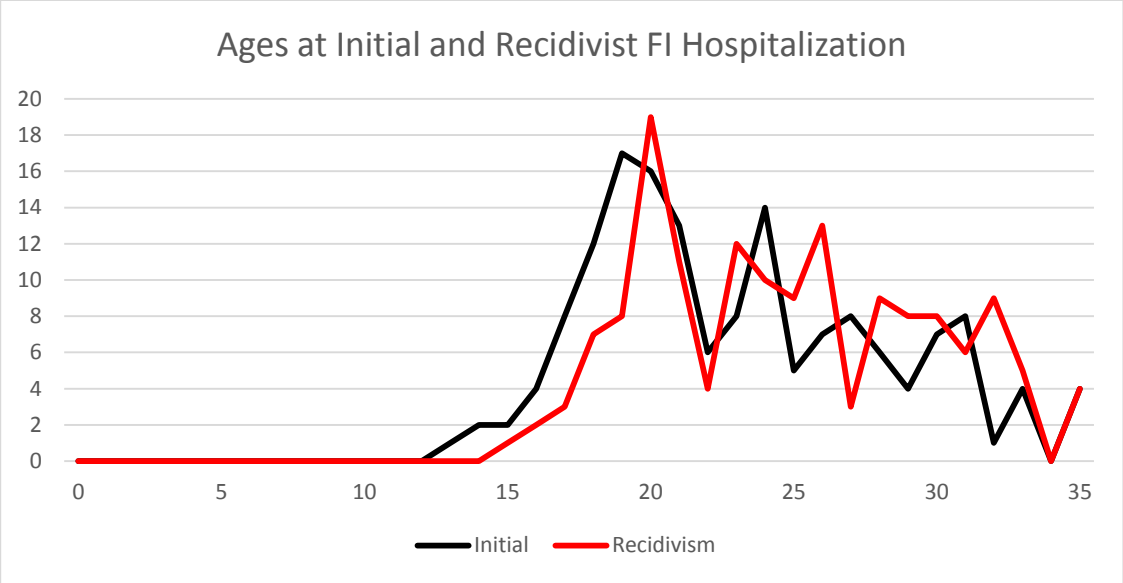


Figure 4.8. Frequency of Recidivists by age at Index and Recidivism FI (n=173)

Table 4.4 compares the characteristics of non-recidivists to recidivists. Recall that those experiencing a FI in Maryland are primarily Black males. A significantly greater proportion of recidivists are Black (98%, χ^2 =25.5, p<.001) and male (97%, χ^2 =6.9, p<.01). Recidivists are significantly younger at their index FI hospitalization with a mean age of 25 years compared to non-recidivists at 28, (t=3.55, p<.001) at the time of their index hospitalization. There are significantly more unspecified intents in the recidivist index hospitalization than those for with a single FI hospitalization. There were also significant differences in the personal disadvantage, working disadvantage, and poverty factors between recidivists and non-recidivists.

Table 4.4 Characteristics of Non-recidivist and Recidivists n=5928

		Non-recidivist						Recidivist						
		n		%				n		%				
Survival	Alive	5755		0.90				152		0.88				
	Dead	616		0.10				21		0.12				
Sex	Male	5265		0.91				168		0.97				**
	Female	490		0.09				5		0.03				
Race	White	724		0.13				3		0.02				
	Black	4794		0.83				169		0.98				***
	Other	237		4.10				1		0.01				
Marital Status	Married	432		0.08				9		0.05				
	Single	5036		0.90				161		0.94				
	Separated/Divorced	145		0.03				2		0.01				
Payor	Private Insurance	1153		0.20				24		0.14				
	Medicaid	2767		0.48				85		0.49				
	Medicare	170		0.03				6		0.03				
	Self-Pay	1665		0.29				58		0.34				
	Other	237		0.04				1		0.01				
Intent	Accident	1196		0.21				42		0.24				
	Assault	3994		0.69				109		0.63				
	Legal Intervention	76		0.01				1		0.01				
	Unspecified	326		0.06				20		0.12				**
	Self-Inflicted	163		0.03				1		0.01				
Weapon	Handgun	1612		0.28				53		0.31				
	Shotgun	221		0.04				6		0.03				
	Hunting Rifle	39		0.01				0		0.00				
	Military	4		0.00				0		0.00				
	Unspecified	3879		0.67				114		0.66				
Substance Use	Alcohol	584		0.10				12		0.07				
	Drug	975		0.17				26		0.15				
	Tobacco	1561		0.27				36		0.21				
Injury Severity	Low ISS (0-8)	1726		0.46				75		0.50				
	Medium ISS (9-14)	1240		0.33				46		0.31				
	High ISS (15 and above)	796		0.21				28		0.19				
		Mean	SD	Median	IQR	Min	Max	Mean	SD	Median	IQR	Min	Max	
	Age at Initial	28	11	25	13	1	95	25	9	23	10	13	70	***
Social Determinants of Health	Personal Disadvantage	45	15	49	27	1	73	50	12	56	11	1	63	***
	Working Disadvantage	27	10	26	16	2	62	32	10	35	14	10	48	***
	Poverty	18	10	14	16	1	49	23	10	24	20	3	40	
	Time to Recidivism							779	752	507	1125	7	3038	

* p<.05, **p<.01, ***p<.001

To examine the independent effect of demographic, injury and social determinants of health on the likelihood of recidivism, bivariate and multivariate logistic regressions were modelled. These models were generally poor with low Cox and Snell R square and Nagelkerke R square. Generalized linear mixed models were attempted to account for the nesting of patients within zip codes (also the level of the social determinants of health); however, the hessian matrix was not positive definite in the null or subsequent models likely reflecting limited variation in random effects. Generalized estimating equations were performed to account for the nesting of individuals within zip codes providing population-based estimates. The original single factor "Disadvantaged" was used as the social determinant of health in these models. As these models were poor due to small cell sizes, the bivariate relationships were examined (Table 4.5). Significant predictive relationships of the likelihood of recidivism within the population include being male, black, self-pay, age, and the racial makeup of the zip code. Blacks were 7 times more likely to be recidivists than Whites and those with payor status of self-pay/ charity are 65% more likely to be recidivists than those with private insurance. Females were 68% less likely to be recidivists than males.

Table 4.5 Unadjusted Bivariate Generalized Estimating Equations of likelihood of Recidivism (n=5928)

		B	SE	Exp(B)	Low CI	High CI
Individual	Female v. Male	-1.14 *	0.55	0.32	0.11	0.94
	Other v. White	0.06	1.16	1.06	0.11	10.27
	Black v. White	2.13 ***	0.59	8.38	2.63	26.69
	Divorced v. Married	-0.42	0.55	0.65	0.22	1.92
	Single v. Married	0.43	0.32	1.53	0.82	2.85
	Self-Pay v. Private Insurance	0.50 *	0.22	1.65	1.08	2.54
	Medicaid v. Private Insurance	0.55	0.47	1.74	0.69	4.36
	Medicare v. Private Insurance	0.39	0.22	1.48	0.96	2.29
	Alcohol Use	-0.41	0.28	0.66	0.38	1.14
	Drug Use	-0.15	0.20	0.86	0.58	1.28
	Tobacco Use	-0.35	0.19	0.71	0.49	1.03
	Age	-0.03 ***	0.01	0.97	0.96	0.99
Social Determinants of Heath	Disadvantaged	0.50 ***	0.07	1.65	1.43	1.91
	Percent Black	0.41 ***	0.08	1.51	1.28	1.78

* p<.05, **p<.01, ***p<.001

To further explore the likelihood of recidivism, a conditional logistic regression model was developed with age. This model used 159 (n = 318) matched pairs of recidivists and non-recidivist by race, gender, payor, and zip code. The pairs do not differ on any characteristic except tobacco use and age (Table 4.6). Recidivists have a significantly smaller proportion of tobacco use than do non-recidivists. The pairs differ in age ($t = 3.8$, $df = 291$, $p<.001$) with recidivists having a mean age of 25 years at their initial FI hospitalization and for non-recidivists the mean age was 29 years.

The conditional model for age is significant ($\chi^2 = 15.3$, $df = 1$, $p<.001$) with age at initial FI hospitalization having an odds ratio of .95 at a mean age of 27 at having recidivism. So, for every year of age below 27, the odds of recidivism increase by 5%; therefore a 16-year-old has 55% greater odds than a 27-year-old. (Table 4.7)

Table 4.6 Characteristics of Matched Pairs of Non-recidivists and Recidivists (n=318) Continued to the top of page 51

		Non-recidivists		Recidivists	
		N	%	n	%
Sex	Male	155	49%	155	49%
	Female	4	1%	4	1%
Race	White	1	0%	1	0%
	Black	157	49%	157	49%
	Other	1	0%	1	0%
Intent	Accident	36	11%	36	11%
	Assault	107	34%	107	34%
	Unspecified	16	5%	16	5%
Weapon	Handgun	46	14%	50	16%
	Shotgun	6	2%	5	2%
	Unspecified	107	34%	104	33%
Marital Status	Married	12	4%	8	3%
	Single	139	44%	148	47%
	Divorced/ Separated	3	1%	2	1%
Payor	Private Insurance	18	6%	18	6%
	Medicaid	82	26%	82	26%
	Medicare	4	1%	4	1%
	Self-Pay/ Charity	55	17%	55	17%
Substance Use	Alcohol Use	22	7%	11	3%
	No Alcohol Use	137	43%	148	47%
	Drug Use	31	10%	24	8%
	No Drug Use	128	40%	135	42%

						Non-recidivists						Recidivists		
						N	%					n	%	
	Tobacco Use					52	16%					31	10%	***
	No Tobacco Use					107	34%					128	40%	
Injury Severity	Low ISS (0-8)					70	22%					78	25%	
	Medium ISS (9-14)					57	18%					50	16%	
	High ISS (15 and above)					32	10%					31	10%	
		Mean	SD	Median	IQR	Min	Maxx	Mean	SD	Median	IQR	Min	Max	
	Age at Index	29	12	26	14	15	77	25	9	23	9	13	70	***

***, p<.001

Table 4.7 Conditional Regression of Likelihood of Recidivism (n=318)

					95.0% CI	
	B	SE	Exp(B)		Lower	Upper
Age at Index	-.053	.015	.95	***	.921	.976

$\chi^2 = 15.3^{***}$, df = 1;
***, p<.001

As FI hospitalizations primarily effect Black males, a rate of FI hospitalizations was created using the total number of Black males in Maryland zip codes as explained in chapter 3. The top 20 resident zip code rates of FI hospitalizations for Black males are found in Table 4.8. A zip code in Salisbury has the highest rate at 71, due to a small denominator. Baltimore City makes up the majority (13 out of 20) of the top twenty zip code rates. The FI hospitalization rates for Black males were mapped with 1 dot equaling 1 FI hospitalization per 1000 Black males per zip code joined with Baltimore City and Maryland counties to show the variation of rates within the state (Figures 4.9 & 4.10).

Table 4.8. Top 20 Zip Codes for FI Hospitalization Rates of Black Males.

Zip	Location	FI Rate for Black Males (per 1000)
21802	Salisbury MD Wicomico County	71.4
21201	Baltimore MD Baltimore city	38.7
21205	Baltimore MD Baltimore city	29.6
21223	Baltimore MD Baltimore city	28.0
21840	Nanticoke MD Wicomico County	26.3
21217	Baltimore MD Baltimore city	25.2
21225	Brooklyn MD Baltimore city	23.6
21213	Baltimore MD Baltimore city	23.2
21216	Baltimore MD Baltimore city	22.4
20609	Avenue MD St. Mary's County	22.2
21230	Baltimore MD Baltimore city	21.3
21218	Baltimore MD Baltimore city	18.7
21229	Baltimore MD Baltimore city	18.5
21224	Baltimore MD Baltimore city	17.8
21215	Baltimore MD Baltimore city	16.9
21631	East New Market MD Dorchester County	16.4
21202	Baltimore MD Baltimore city	15.8
20658	Marbury MD Charles County	15.5
21231	Baltimore MD Baltimore city	15.4
20777	Highland MD Howard County	12.8

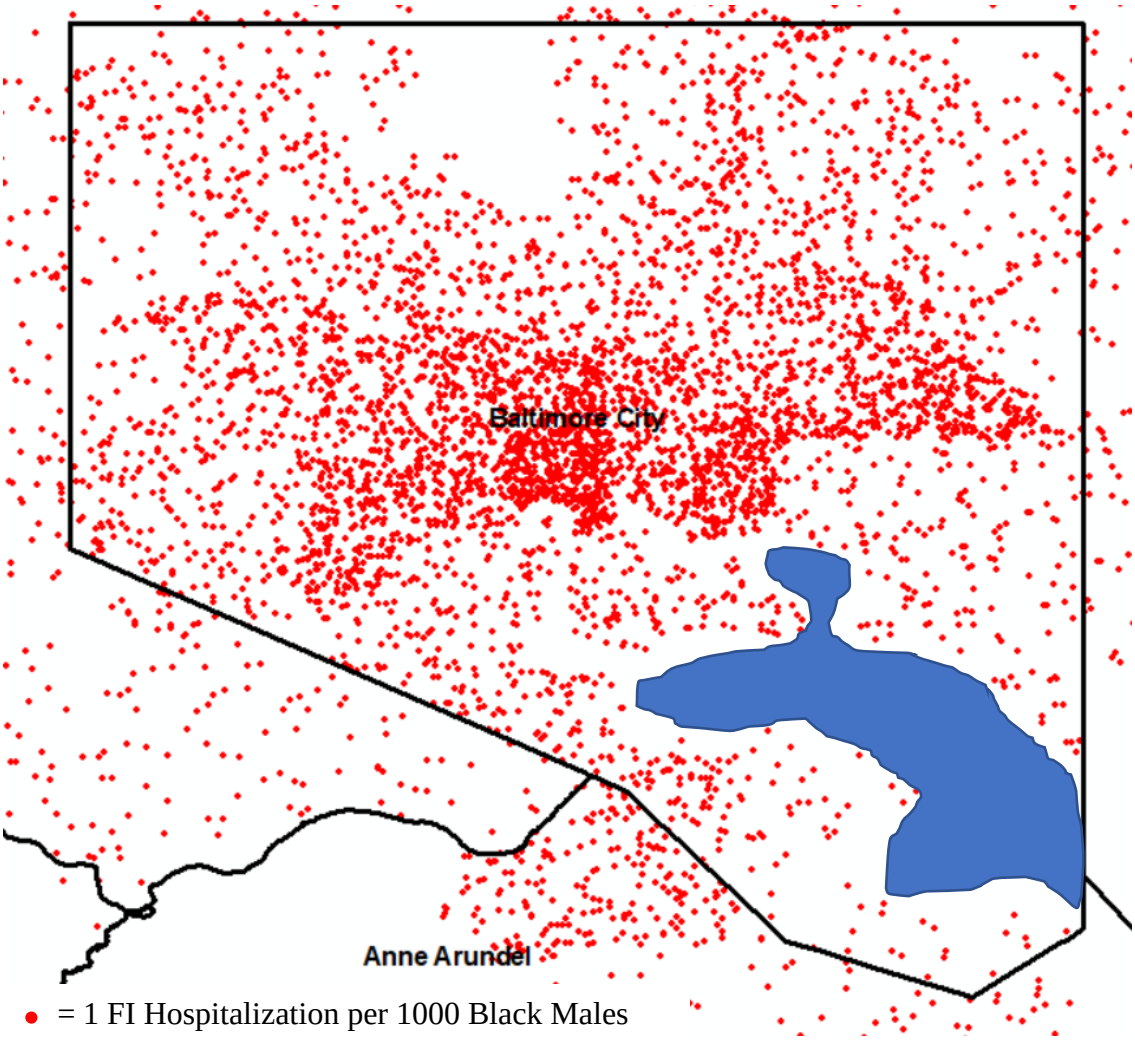


Figure 4.9 Rates of FI Hospitalizations of Black Males for Baltimore City, 2005-2014

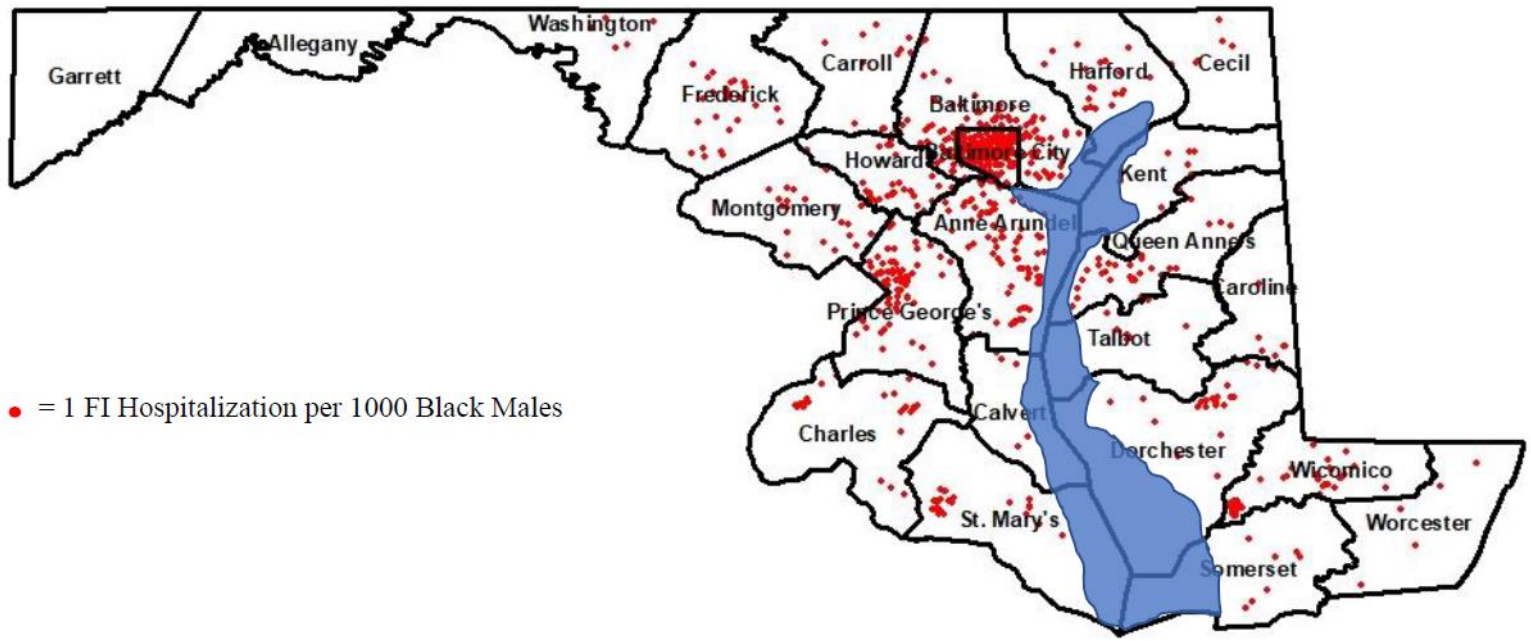


Figure 4.10. Rates of FI Hospitalizations of Black Males in Maryland, 2005-2014

The density map shows clustering of FI hospitalization rates for Black males in and around Baltimore City and Prince George's County, a suburb of the District of Columbia and relatively no FI hospitalizations for Western Maryland.

The relationships of the social determinants of health on the frequency of FI hospitalizations of Black males for each zip code (n=457) were modeled using a single level negative binomial generalized linear model (Table 4.9). The pseudo R^2 was calculated as 0.45. Each the 3 latent factors, Personal Disadvantaged, Working Disadvantaged, and Poverty were significant predictors of the frequency of FI hospitalizations of Black males by the individual's zip code of residence. The Personal Disadvantaged factor has an incidence rate ratio (IRR) of 1.13, the Working Disadvantaged factor of 1.04, and the Poverty factor of .97. So, for every point increase in the Personal Disadvantaged factor greater than 20, the rate of FI hospitalizations increases by 13%, a 1-point increase in the Working Disadvantaged factor greater than 17 increases the rate by 4%, and a 1-point increase in the Poverty factor greater than 11 reduces FI hospitalizations by 3%. There were no significant interactions between the factors at predicting FI hospitalization for Black males.

Table 4.9. Relationship of Social Determinants of Health on Frequency of FI Hospitalizations in Black Males, 2005-2014, n=457

				95% CI	
Parameter	B	SE	Exp(B)	Lower	Upper
Intercept	-2.18 ***	.17	.11	.08	.16
Personal Disadvantage	0.13 ***	.01	1.13	1.12	1.15
Working Disadvantage	0.04 ***	.01	1.04	1.02	1.07
Poverty	-0.04 **	.01	.96	.94	.99

R^2 = .45; * p<.05, **p<.01, ***p<.001

4.3. Hospital Costs

Annual summed hospital costs totaled between $12.7 and $23 million for the state of Maryland. The characteristics for the cost analysis of 542 FI hospitalizations from 516 individuals in 2013 (Table 4.10) were primarily young (median = 27), single (85%) Black (81%), males (90%) with Medicaid (46%) because of an assault (72%). The 26 (5%) duplicate admissions were from transfers to a higher level of care (7, 27%), readmission (11, 42%) and recidivism (6, 23%). In 2013, FI hospitalizations totaled $14 million in hospital costs, of which 25% (129) of the 516 individuals accounted for over $10 million.

The most common injury reported was related to the leg (24%). Mechanical ventilation was needed by 22%, while 19% needed blood transfusion. The chest was injured in 11% of patients and 11% needed chest tube insertion. Substance use was prevalent with 16% having a diagnosis code related to drug use and 7% with alcohol use. Mean hospital costs adjusted from total charges was $27,085 ($56,901) with median hospital costs at $11,389 and ranged from $765 to $964,148.

Table 4.10. Demographics for 2013 FI Hospitalizations. (n=519) Continued to the top of page 58

		Frequency	Percent
Sex	Male	465	90
	Female	51	10
Race	Black	420	81
	White	81	16
	Other	15	3
Marital Status	Single	440	85
	Married	42	8
	Separated/ Divorced/ Widowed	19	4
	Missing	15	3
Payer	Medicare	18	4
	Medicaid	241	47
	Private	93	18
	Self-Pay/ Charity	164	32
Intent of Firearm Injury	Accident	67	13
	Assault	375	73
	Legal Intervention	9	2
	Unspecified	36	7
	Self-Inflicted	29	6
Weapon	Handgun	177	34
	Shotgun	22	4
	Hunting Rifle	5	1
	Unspecified	312	61
Injury Severity	Low (0-8)	213	41
	Medium (9-14)	159	31
	High (15 and above)	144	28
Injury Type	Leg Injury	125	24
	Lung Injury	83	16
	Arm Injury	63	12
	Chest Injury	56	11
	Bowel Injury	49	10
	Liver or Spleen Injury	42	8
	Back Injury	41	8
	Abdominal Injury	35	7
	Retroperitoneal Injury	26	5
	Paraplegia	8	2
Procedures	Mechanical Ventilation	113	22
	Blood Transfusion	99	19
	Intubated	87	17
	Wound Care	84	16
	Chest Tube Insertion	58	11
	Central Venous Catheter	57	11
	Antibiotics	26	5

		Frequency	Percent
Substance Use	Small Bowel Resection	23	5
	CPR	19	4
	Fasciotomy	13	3
	Total Parenteral Nutrition	8	2
	Enteral Nutrition	6	1
	Tobacco Use	129	25
	Drug Use	82	16
	Alcohol Use	37	7

	Mean	SD	Median	IQR	Minimum	Maximum
Hospital Cost	$27,085	$56,901	$11,389	$24,398	$765	$964,148
Age	30	12	27	12	4	95
Hospital LOS	5	9	2	5	0	119

The results of bivariate regression of predictors and hospital costs using both linear regression with log transformed costs and the generalized linear model with a gamma distribution are presented in table 4.11. The linear regression models provide an R^2 for the explanatory effect of the predictor. The results of both models were similar. The hospital costs did not have to be transformed with the gamma distribution, so the marginal mean hospital costs for those with and without a characteristic are provided. Significant predictors of increased costs were abdominal injury, bowel injury, chest injury, liver or splenic injury, lung injury, retroperitoneal injury, mechanical ventilation, small bowel resection, chest tube insertion, total parenteral nutrition (TPN), fasciotomy, and enteral nutrition. For example, TPN in the linear regression model had an R^2=.04, indicating it explains 4% of the variation in hospital costs, while the gamma distribution model provides coefficient of $e^{1.62}$ indicating it increased hospital costs 5 times ($129,076) the mean costs for those without TPN ($25,479). A liver or splenic injury has an R^2=.11, and the gamma distribution had a coefficient of $e^{.1.25}$ indicating it increases hospital costs 3.5 times ($78,618) the mean of someone without a liver or splenic injury ($22,519).

The multivariate analysis (Table 4.12) of the log transformed hospital costs models with an adjusted R^2=.46, F=19, df=23, p<.001. Significant predictors of the log of costs include being self-pay/ charitable, having medium or high ISS, a bowel injury, liver or spleen injury, having a blood transfusion, being on mechanical ventilation, having antibiotics, total parenteral nutrition, having a fasciotomy or needing wound care. These predictors are also significant in the generalized linear model (GLM) with gamma distribution. In this multivariate model, holding all other factors constant, the individual with a bowel injury is likely to have hospital costs that are 2.34 times ($604,737) that of someone without ($258,454), as does having a liver or spleen injury at 2.15 times ($579,963) that of someone without ($269,494). Being mechanically ventilated is also likely to double the costs at 2.29 ($598,705). Having a transfusion is likely to increase hospital costs by 47%, as does the need for wound care at 49%. The individual needing total parenteral nutrition (TPN) is likely to increase hospital costs by 3.38 times ($827,717) and a fasciotomy at 2.88 times ($778,923).

Table 4.11. Bivariate Regression Models of Hospital Cost (n=516) Continued to the top of page 60-61

	OLS					GLM with Gamma Distribution				
	Coefficient	SE	Lower	Upper	Adjusted R^2	Coefficient	SE	Lower	Upper	Estimated Mean
Age	0	0.004	-0.009	0.008	0.00	-0.01	0.00	-0.02	0.00	
Female	-0.13	0.14	-0.49	0.23	0.00	-0.14	0.17	-0.20	0.48	$23823.63
Male	Ref.					Ref				$27443.21
Other	-0.19	0.35	-0.88	0.49	0.00	-0.42	0.33	-1.06	0.23	$17400.60
Black	-0.09	0.15	-0.38	0.21		0.04	0.14	-0.24	0.32	$27559.38
White	Ref					Ref				$26421.63
Self-Pay/Charity	-0.63***	0.16	-0.93	-0.32	0.06	-0.89***	0.15	-1.18	-0.60	$15516.32
Medicare	-0.10	0.31	-0.71	0.50		-0.66*	0.29	-1.23	-0.09	$19524.06
Medicaid	0.10	0.15	-0.19	0.39		-0.19	0.14	-0.457	0.087	$31396.63
Private Insurance	Ref					Ref				$37778.51
Separated/ Divorced	-0.37	0.34	-1.05	0.31	0.00	-0.46	0.32	-1.09	0.18	$18680.05
Single	0.00	0.20	-0.40	0.39		-0.06	0.19	-0.43	0.31	$27710.92
Married	Ref					Ref				$29454.79

High ISS	1.13***	0.12	0.89	1.37	0.16	0.90		0.69	1.12	$47363.89
Medium ISS	0.88***	0.12	0.65	1.12						$19234.75
Low ISS	Ref					Ref				
Abdomen	0.04	0.22	-0.39	0.46	0.00	0.64**	0.24	0.24	1.04	$48514.41
No Abdomen	Ref					Ref				$25526.78
Arm	-0.36*	0.17	-0.68	-0.03	0.01	-0.28	0.16	-0.59	0.03	$21023.84
No Arm	Ref					Ref				$27928.47
Back	-0.16	0.20	-0.56	0.24	0.00	-0.08	0.19	-0.45	0.30	$25230.24
No Back	Ref					Ref				$27245.60
Bowel	1.46***	0.17	1.11	1.80	0.12	1.17***	0.17	0.84	1.50	$72168.29
No Bowel	Ref					Ref				$22355.15
Chest	0.67***	0.18	0.33	1.01	0.03	0.56**	0.16	0.24	0.89	$44007.82
No Chest	Ref					Ref				$25025.35
Leg	-0.18	0.13	-0.43	0.07	0.00	-0.29*	0.12	-0.53	-0.06	$21559.89
No Leg	Ref					Ref				$28851.95
Liver or Spleen	1.49***	0.19	1.12	1.86	0.11	1.25***	0.18	0.90	1.60	$78618.43
No Liver or Spleen	Ref					Ref				$22519.25
Lung	0.54***	0.15	0.25	0.83	0.02	0.83***	0.14	0.56	1.09	$51223.70
No Lung	Ref					Ref				$22458.50
Para	0.10	0.44	-0.77	0.96	0.00	-0.59	0.42	-1.41	0.23	$15105.25
No Para	Ref					Ref				$27274.13
Retroperitoneal	1.21***	0.24	0.73	1.68	0.04	0.78**	0.23	0.32	1.24	$55788.77
No Retroperitoneal	Ref					Ref				$25562.43
PRBC	1.11***	0.13	0.85	1.36	0.12	0.68***	0.13	0.43	0.94	$45143.03
No PRBC	Ref					Ref				$22798.41
MV	1.00***	0.13	0.75	1.24	0.11	1.21***	0.11	0.98	1.43	$59862.23
No MV	Ref					Ref				$17894.96
CVC	0.20	0.174	-0.14	0.54	0.00	0.15	0.16	-0.18	0.47	$30819.91
No CVC	Ref					Ref				$26621.71
Sm. B. Res	1.57***	0.26	1.07	2.07	0.07	1.05***	0.25	10.03	10.23	$71328.17
No Sm. B Res..	Ref					Ref				$25007.41
Chest tube	0.64***	0.17	0.31	0.98	0.03	0.38*	0.16	0.06	0.70	$37617.14
No Chest Tube	Ref					Ref				$25751.76
Antibiotics	0.97***	0.25	0.49	1.45	0.03	0.36	0.24	-0.10	0.83	$38123.00
No Antibiotics	Ref					Ref				$26499.80
TPN	2.14***	0.43	1.29	2.99	0.04	1.62***	0.41	0.82	2.43	$129076.13
No TPN	Ref					Ref				$25479.31
Fasciotomy	1.59***	0.34	0.92	2.26	0.04	0.95**	0.33	0.31	1.59	$67226.08
No Fasciotomy	Ref					Ref				$26048.03
Enteral Nutrition	1.38*	0.51	0.39	2.38	0.01	0.98*	0.48	0.04	1.92	$70733.00
No Enteral Nutrition	Ref					Ref				$26571.96
Wound Care	0.37*	0.15	0.08	0.66	0.01	0.09	0.14	-0.19	0.36	$29106.71
No Wound Care	Ref					Ref				$26692.44

ISS, Injury Severity Score; Para, Paraplegia; PRBC, Packed Red Blood Cells; MV, Mechanical Ventilation; CVC, Central Venous Catheter; Sm B Res, Small Bowel Resection; TPN, Total Parenteral Nutrition;

Table 4.12 . Multivariate Regression on Healthcare Costs (n=516) Continued to the top of page 63

	OLS Regression with Log Cost								Generalized Linear Model with Gamma Distribution with Cost				
			95% CI				95% CI					95% CI	
	B	SE	Low	High	B	SE	Low	High	Exp (B)	Mean	SE	Low	High
Intercept	8.47	0.25	7.98	8.97	8.93	0.26	8.42	9.45	7589				
Age	0.00	0.00	-0.01	0.01	0.00	0.00	-0.01	0.01	1				
Female	-0.02	0.14	-0.28	0.25	-0.13	0.13	-0.39	0.12	.88	$369,747.52	$148,281.52	$168,478.34	$811,458.80
Male	Ref				Ref				1	$422,712.78	$159,040.12	$202,205.05	$883,687.61
Other Race	0.04	0.29	-0.52	0.59	-0.42	0.28	-0.97	0.12	.66	$336,539.48	$151,270.79	$139,453.78	$812,160.29
Black	-0.04	0.13	-0.29	0.21	-0.36 **	0.13	-0.61	-0.11	.67	$357,372.54	$131,979.55	$173,287.80	$737,011.65
White	Ref				Ref				1	$513,770.04	$201,830.41	$237,892.70	$1,109,574.40
Self-Pay/ Charitable	-0.46 ***	0.13	-0.71	-0.21	-0.45 ***	0.13	-0.70	-0.20	.64	$269,829.37	$105,031.14	$125,822.65	$578,654.87
Medicare	0.07	0.26	-0.45	0.58	0.14	0.26	-0.36	0.65	1.15	$486,949.96	$216,885.23	$203,405.72	$1,165,750.22
Medicaid	0.01	0.12	-0.22	0.24	0.04	0.12	-0.19	0.27	1.04	$439,805.84	$164,383.10	$211,404.12	$914,973.53
Private Insurance	Ref				Ref				1	$422,733.57	$165,566.49	$196,194.95	$910,847.44
Separated/Divorced/Widowed	-0.04	0.25	-0.54	0.46	0.48	0.25	-0.02	0.98	1.62	$477,409.13	$209,945.43	$201,635.20	$1,130,355.59
Single	0.19	0.16	-0.13	0.51	0.40 *	0.16	0.08	0.72	1.49	$438,573.31	$166,026.97	$208,838.26	$921,031.18
Married	Ref				Ref				1	$295,116.20	$115,002.28	$137,496.86	$633,422.25
High ISS (15-75)	0.51 ***	0.12	0.28	0.75	0.56 ***	0.11	0.33	0.78	1.75	$479,233.98	$186,708.41	$223,316.86	$1,028,427.52
Medium ISS (9-14)	0.57 ***	0.10	0.37	0.77	0.54 ***	0.10	0.33	0.74	1.71	$469,795.75	$182,468.74	$219,433.17	$1,005,809.85
Low ISS (0-8)	Ref				Ref				1	$274,453.82	$106,412.65	$128,362.16	$586,815.46
Bowel Injury	0.81 ***	0.17	0.48	1.14	0.85 ***	0.15	0.56	1.14	2.34	$604,737.30	$239,990.55	$277,822.01	$1,316,336.33
No Bowel Injury	Ref				Ref				1	$258,454.38	$99,261.67	$121,750.98	$548,649.91
Liver or Spleen Injury	0.93 ***	0.17	0.60	1.26	0.77 ***	0.16	0.46	1.08	2.15	$579,963.78	$234,364.75	$262,680.78	$1,280,481.92
No Liver or Spleen Injury	Ref				Ref				1	$269,494.42	$101,853.32	$128,482.73	$565,268.50
Lung Injury	-0.03	0.12	-0.27	0.21	0.10	0.12	-0.14	0.34	1.11	$416,401.69	$165,288.32	$191,263.81	$906,550.84
No Lung Injury	Ref				Ref				1	$375,351.51	$142,269.21	$178,569.74	$788,984.49
Paraplegia	0.51	0.35	-0.17	1.20	0.36	0.34	-0.31	1.03	1.43	$472,941.41	$231,150.04	$181,460.75	$1,232,627.83
No Paraplegia	Ref				Ref				1	$330,478.57	$111,073.29	$171,023.54	$638,602.65
Retroperitoneal Injury	0.25	0.20	-0.14	0.65	0.23	0.19	-0.13	0.60	1.26	$444,483.22	$182,261.62	$198,983.81	$992,871.41
No Retroperitoneal Injury	Ref				Ref				1	$351,637.57	$133,021.74	$167,529.92	$738,071.03
Blood Transfusion	0.42 ***	0.11	0.20	0.64	0.39 ***	0.11	0.17	0.60	1.47	$479,658.82	$186,575.17	$223,787.86	$1,028,083.38

No Blood Transfusion	Ref				Ref				1	$325,850.37	$125,464.99	$153,204.92	$693,048.66
Mechanical Ventilation	0.59 ***	0.11	0.37	0.82	0.83 ***	0.11	0.61	1.05	2.29	$598,705.20	$228,661.29	$283,215.31	$1,265,637.48
No Mechanical Ventilation	Ref				Ref				1	$261,058.37	$102,580.43	$120,855.38	$563,909.31
Small Bowel Resection	0.08	0.25	-0.40	0.57	0.00	0.24	-0.46	0.47	1.00	$396,228.38	$161,403.38	$178,323.74	$880,403.94
No Small Bowel Resection	Ref				Ref				1	$394,461.91	$155,646.20	$182,028.43	$854,812.60
Antibiotics	0.38 *	0.19	0.00	0.75	0.37 *	0.18	0.01	0.73	1.45	$475,705.62	$195,923.04	$212,209.26	$1,066,380.57
No Antibiotics	Ref				Ref				1	$328,558.24	$123,310.12	$157,452.91	$685,605.09
Total Parenteral Nutrition	1.14 ***	0.35	0.47	1.82	1.48 ***	0.34	0.80	2.15	4.38	$827,717.98	$388,097.85	$330,197.39	$2,074,871.17
No Total Parenteral Nutrition	Ref				Ref				1	$188,828.81	$68,928.89	$92,331.73	$386,176.24
Fasciotomy	1.45 ***	0.26	0.93	1.97	1.36 ***	0.25	0.86	1.85	3.88	$778,923.59	$344,501.12	$327,360.86	$1,853,373.54
No Fasciotomy	Ref				Ref				1	$200,657.68	$72,317.77	$99,010.12	$406,660.50
Enteral Nutrition	0.35	0.40	-0.42	1.13	0.15	0.37	-0.58	0.88	1.16	$426,193.28	$212,319.57	$160,530.59	$1,131,502.17
No Enteral Nutrition	Ref				Ref				1	$366,727.98	$123,988.78	$189,041.57	$711,427.70
Wound Care	0.40 ***	0.11	0.17	0.62	0.40 ***	0.11	0.18	0.62	1.49	$482,156.56	$189,532.91	$223,144.28	$1,041,814.51
No Wound Care	Ref				Ref				1	$324,162.34	$123,631.64	$153,505.69	$684,542.85

OLS, Ordinary Least Squares; Adjusted R^2=.46, F=19.17, df=23

* p <.05; ** p<.005; ***p<.001; Ref, Reference

CHAPTER 5: DISCUSSION

This chapter includes the findings, limitations, implications, future research and conclusions.

5.1 Findings

Like national trends[6,21-25], this study found a disparity in FI hospitalizations of Marylanders with most occurring in young Black males because of an assault, which primarily seem to begin at age 14 as depicted in Figure 4.4. The mortality for those with FI hospitalization (9%) is also like those reported for the nation between 4.7 and 14%.[8,16,21,28] For overall mortality, those reported by the Medical Examiner's Office would include those listed here, but also those FI which resulted in death which never make it to a hospital. The 0% fatality in 2013 for Figure 4.2 is most likely a coding error. Most of the injuries were of low severity. The most frequently occurring injury occurs to the leg (21%) in this sample, which is the same as what is reported for chest and abdominal injuries for the nation.[28] Urban areas such as Baltimore City, Baltimore County and the suburbs of the District in Columbia in Prince George's County account for over 80% of the FI hospitalizations driving hospital costs which are predominantly paid by Medicaid (46%) or uncompensated care as self-pay/ charity (32%). Both Baltimore City and Prince George's County had steady declines in the percentage of FI hospitalizations from 2006-2014. What happened during this time? FI hospitalizations fluctuate seasonally which may impact hospital staffing, especially since they peaked in July, which is also a popular staff vacation time and the start of physician residency programs.

Multilevel analysis of individual characteristics and latent variables for social determinants of health were limited do to the lack of variability within the sample (Appendix C). This likely resulted in over fitting and resulted in low R squares. Although these numbers are statistically low, clinically they may provide characteristics of individuals to target for prevention of recidivism. Age was a significant predictor of recidivism, which can provide a target group for hospital intervention programs. The median time of 507 days may indicate that the individuals are not retaliating, but as the Pittsburg Youth study posit, the individuals maybe more likely to encounter violence. It was surprising that alcohol and substance use were not associated with recidivism, but not smoking was. The factor poverty reducing the number of FI hospitalizations in Black males may act like Burgason's "disadvantaged",[30] which also saw a reduced likelihood of being injured. This may be related to public assistance providing the needs, so that illegal means of survival aren't needed (not likely) or they may be more "street wise" and able to avoid victimization. The latent variables of "Personal Disadvantage" and "Working Disadvantage" were both independently associated with higher IRR of FI hospitalizations of Black men while controlling for each other and "Poverty". "Poverty" showing decreased IRR of FI hospitalizations of Black men while controlling for "Personal Disadvantage" and "Working Disadvantage" is likely due to Poverty being linked within both measures. Future investigations may use other measures of "Disadvantage" such as the "Area Deprivation Index".[43]

Not surprising, the major expenses involved with hospital costs for a FI hospitalization are related to abdominal injuries, operative procedures and critical care costs such as mechanical ventilation, transfusion, and TPN. These patients usually have

prolonged hospital stays related to their need for initial damage control surgery, resuscitation from blood loss, multiple operative procedures for intra-abdominal organ repair with an inability to provide nutrition enterally. Interestingly, the need for a fasciotomy increased the cost of hospital care by almost 3 times that of those without. This may be related to a need for critical care services associated with compartment syndrome and rhabdomyolysis with acute kidney injury requiring renal replacement. These costs are strictly the costs of hospitals to provide care to individuals with FI and do not include emergency medical services fees, professional fees, costs of follow-up services, or any costs associated with rehabilitation or sub-acute care.

5.2 Implications

A single shift in an urban trauma center occurring as this document is being written provides some context for this study. Between noon and 3pm, 5 patients, 4 males and a female, all Black, arrived due to FI. Two of these patients died due to FI to the head. Another male arrived suffering a flesh wound because he was too close to a victim and a bullet ricocheted off the skull of one patient and hit him. He was able to be sent home. A male shot in the chest and a female shot in the hip were emergently taken to the OR. This is Baltimore City's reality. These two patients will likely have hospital costs greater than $400,000 as they both had a medium to high ISS.

This study provides some findings to influence policy and practice related to FI. The reasons for the disparity in FI hospitalizations in young Black males are multifactorial including race, stereotypes, and social determinants of health. Race is a construct in the human social paradigm that identifies a person based on a physical characteristic and represents cultural, historical, religious, or other social characteristics.

Although race is a social construct to identify a person, it is no less important or powerful for being a social determinant of health when used to investigate differences in human social structures, particularly in the United States. Specifically, regarding violence and victimization, there is no aspect of violence and victimization that is not affected by race.[44]

When examining victimization by race, Whites and Blacks experience similar victimization rates except for those that involve a weapon, particularly a firearm.[45] Findings from Zimmerman & Messner[46] indicate that family background factors, individual differences, and neighborhood characteristics vary significantly by race/ethnicity, and that this variation contributes to the understanding of racial/ ethnic disparities in exposure to violence. Levels of household socioeconomic status were lower, and rates of violent peer exposure and previous violent behavior were higher, among Blacks than Whites and that neighborhood context is a significant factor with disproportionate amount of disadvantage falling in minority neighborhoods[46] as was found in this study in modeling FI hospitalization rates of Black men. Similarly, this study found the Personal Disadvantage factor (female head of household with child, Black, and non-owner occupied housing) and the Work Disadvantage factor (unemployment, grade 12 or less, and income of $25,000 or less) were associated with increased frequencies of FI hospitalizations in Black males. This may be a vicious cycle, as the personal factor was associated with higher numbers of FI hospitalizations in Black males, which could leave fewer Black males around as future father figures, which again forces more single women to raise children and be the bread winner with potentially inadequate parenting. A study[47] of racially and ethnically disaggregated

arrest data from California and New York examined race and ethnic gaps in both homicide and the violent crime index and found disparities in disadvantage, particularly family structure and poverty, are important in driving racial and ethnic disparities in crime. This association was also found in this study of victimization in Black males, which were mostly the result of a crime, an assault.

Media and pop culture also play a role in perpetuating stereotypes and differences in the social constructs of race. The mass shootings in Sandyhook, CT; Orlando, FL, Denver, CO, Las Vegas, NV, which all involved white male perpetrators have all sparked wide-spread support of gun control policies; however, prior to these events numerous children and adults, mostly black and from low-income neighborhoods were and continue to be victims of or a witness to gun violence, with very little coverage.[48] Media often focus on crime especially in which the assailant is Black and the victim is a female or White, which perpetuates the stereotype of where Blacks are perceived as criminally inclined and create a subjective reality where crime is simply the cultural norm in urban areas facilitating a notion that the shooting deaths of children or minors in urban areas are an unfortunate manifestation of that norm.[48] This may be true in Maryland, as it is frequently reported that Baltimore is one of the most dangerous cities in the United States, although the percentage of FI hospitalizations dramatically decreased from 2006 to 2014.

The issue of race appears not to be about skin color per se, but more about the perceptions and stereotypes about the factors associated with being disadvantaged. These perceptions and stereotypes impact the media and law, creating a cycle of perpetuation on both Whites and Blacks. In order to impact the disparities in violence

between Blacks and Whites, the social determinants of health must be considered as indicated in Sampson's model of context.

Violence, including FI, in America's cities is a multifaceted crisis that will require multifaceted interventions with short term goals of interrupting ongoing violence and long-term goals of preventing future violence. Urban areas in Maryland are no different. Violence intervention programs have shown significant associations with reduced potential for recidivism in both violent injury and commitment of crime. These studies have been limited to urban areas in associated trauma centers, thus may not be generalizable to suburban or rural areas.[49-53] These studies are limited by sample size and loss to follow-up. Many patients were excluded from studies as they lived outside of referral service areas.

In a multivariate analysis[54] of 51,487 patients to determine the type of facility (trauma center vs. nontrauma center) where injured youth (aged 15–24 years) presented for assessment after intentional injury, those with injuries due to blunt objects {odds ratio [OR], 1.51 [95% confidence interval (CI): 1.39 – 1.65]}, stab wounds [OR, 1.62 (95% CI: 1.50 – 1.75)] or firearm [OR, 4.18 (95% CI: 3.21 – 5.45)] were more likely to be treated at trauma centers than those injured by bodily force. Eighty percent (80%) of youth injured by violence were treated at nontrauma centers. The researchers concluded that violence prevention programs should be implemented and evaluated in nontrauma centers as secondary prevention initiatives, while those programs at trauma centers focus on tertiary prevention initiatives.

Given that those with FI are overwhelmingly the result of violence (68% related to assault) and are seen in hospitals, hospital-based violence intervention programs

make sense. The National Network of Hospital-based Violence Intervention Programs'[55] mission is to strengthen existing hospital-based violence intervention programs and help develop similar programs in communities across the country. Current membership includes 28 programs with 8 emerging programs. They currently offer services, for a fee, to organizations engaged in developing a violence intervention program (Appendix D).

The Health Belief Model[56] (HBM) has been used to describe and predict health behaviors in injury prevention. Any health-related message is a function of the degree to which the individual feels vulnerable to the health outcome, the severity of the consequences, the benefits associated with behavior change, and self-efficacy to change. Given this framework, Johnson et al[49] sought to determine if the emergency department setting was appropriate for a "teachable moment" by creating a "teachable moment index" using factor analysis with 6 questions related to the HBM. They found that the emergency department may be an important place, and injuries may be an important context, for increasing youths' and parents' perceived ability to prevent future assault injuries and violence. As well as the teachable moment, assessment of injured individuals and their families for the potential for retaliation[51], which could lead to re-injury or committing a violent crime, should be conducted prior to discharge and included in any intervention program. Retaliation was an operational definition for recidivism in this study; however, given the median length of time to recidivism of 507 days, may not be a cause of FI hospitalizations.

There are challenges to overcome in implementing hospital-based violence intervention programs, such as knowledge deficit of caregivers. In a survey[57] of

members of the American College of Physicians, 85% of respondents believe firearm injury to be a public health issue and 71% believe it to be a bigger problem today than a decade ago. Fifty-eight percent of the respondents also reported that they had never asked patients if they had a gun in their homes. Healthcare providers may have confusion[58] regarding their ability to ask about firearms due to state laws and amendments to the Affordable Care Act. Laws restricting the healthcare practitioner's ability to discuss firearms with patients have been declared unconstitutional and blocked from enforcement.

They may also be conflicted about what to do if a patient screens positive for being at risk for violence. Prevention training has been developed for healthcare providers by the American Medical Association[59], Emergency Nurses Association[60], Massachusetts Medical Society[61], and the National Training Initiative on Injury and Violence[62]. These programs are intended to facilitate changes in individual and cultural awareness and foster prevention of violence.

Hospital-based violence intervention programs have shown some effectiveness in preventing recidivism of both re-injury and commitment of violence. Programs are available to train healthcare professionals. A larger study of these programs is warranted to determine their effect on a larger scale. As FI continues to burden the healthcare system and society, programs that reduce their numbers are beneficial. This study found an association between age and recidivism. As the majority of FI hospitalizations are of young Black males, this population should be targeted. For prevention of FI hospitalizations, youth who are younger than 13 years of age and not

experienced a FI should have intervention as well as anyone who has a FI hospitalization who is as young as age 15 to prevent recidivism.

Larger community prevention programs should be supported as standard models of policing by enforcing the law in a general reactive way have shown limited effectiveness in reducing crime [63]. The results of this study can be used to target high risk neighborhoods or zip codes. The Cure Violence Model provides a framework for a multifaceted intervention to interrupt current levels of violence within neighborhoods.

The Cure Violence Model relies on direct interruption of transmission, identifying and changing the thinking of potential transmitters and changing group norms regarding violence [64]. The intervention of the model involves the coordination of many intricate processes. Coordination of a response with simultaneous efforts of the criminal justice system and specific members within the community are deployed to interrupt the occurrence of violence within the neighborhoods. The criminal justice system disrupts gang activity through drug seizures, serving warrants, making arrests, stiffer plea bargains, etc. Meanwhile, hired rehabilitated community workers specifically recruited based on their background (e.g. reputation, violent history, victim of a shooting, gang involvement, etc.) focus attention on interrupting those involved in violence and provide alternatives to conflict, *violence interrupters*. *Outreach workers* are also deployed to change social norms focusing attention on connecting those involved with violence to other more positive resources, such as employment and housing.[64]

This model has been deployed and studied in eleven US cities including Boston, Newark, Honolulu, Los Angeles, Chicago, and Baltimore. Although the studies were

not randomized controlled trial and were quasi-experimental in design, an overall positive effect was seen in a recently published meta-analysis [65]. The overall estimated effect size was 0.60, representing a slightly larger than medium effect.

One study [66] by using focus groups of violence interrupters and outreach workers examined how the programs prevent imminent violence. They emphasized the importance of being in the community to identify unusual patterns, one individual is quoted "Sometimes you just can look at the guys and know. You can feel the tension." when identifying a need for intervention. [66] To be effective they describe needing to first gain the trust of the individuals, "Yo, this is Safe Streets, we don't work with the police, ain't no snitching stuff" [66]. For immediate mediation they use many tools including agreements, buying time, personal consequences, third parties, etc. They report the most difficult mediations are those where violence is to be used for retaliation for a prior homicide or large amounts of money were involved.

This model has effects at all levels of the Social-Ecological model including the individual, relationship, community, and societal and is in the CDC's *Developing and Testing Prevention Strategies of the Public Health Approach to Violence Prevention*.[64] Although it may not be possible to study using randomized controlled methods, the successes are promising and require further study and support in pragmatic trials. A sub analysis of data from this study could be completed to test the effects of Safe Streets Baltimore on FI hospitalizations.

In an interview with Baltimore City Mayor Pugh in December 2017,[67] $10 million was sought from philanthropic funds to expand Safe Streets Baltimore from 4 neighborhoods to 11. Given that more than $10 million in hospital cost have occurred

every year between 2005 and 2014, with almost 50% of these attributed to Medicaid and 29.6% as self-pay/ charity, the limitation of Federal funding of FI research must end. To impact FI reductions, large scale studies of violence and its prevention are needed. For instance, the money needed to cover the hospital costs of 25% of the patients for a single year (2013) would have covered the funds needed to expand the Safe Streets prevention program. This would be money well spent that could reduce future FI hospitalizations and not just the financial costs, but also the physical and emotional costs of victims, their families as well as the impact to those who work to save their lives.

5.3 Limitations

This study has several limitations. This is a study of FI hospitalizations only. It does not include any case or information from emergency medical services or the medical examiner as there is no way to link those data. The study may have sample bias as it uses a convenience sample and only examines FI hospitalizations and does not include any FI that may have been untreated or died at the scene. The data set was unidentified, so some FI hospitalizations could be misclassified based on the assumption that the individual remained in the same zip code for 10 years. There was also no variable which explicitly identified recidivism, so the prevalence of recidivism may be more or less than 3%; however, is plausible given that a prevalence of recidivism was 2% in the Shock Trauma data. The effects of the social determinants on recidivism were limited due to too little variation in the neighborhood level SDOH context of occurrence of recidivism and is limited to overall FI rates of Black males. Zip code is also a poor representation of neighborhood[68,69] and may not represent the

social determinants of health for the individuals within the neighborhood. The costs are limited to the costs of hospitals to care for these patients and does not include the emotional costs to the victims and their families nor does it account for the compassion fatigue and burnout hospital staff may incur. As the majority of these hospitalizations are from urban areas effecting mostly Black males, they may not be generalizable to other populations.

5.4. Future Research

Future research should include more granular characterization of FI through a joined registry of sorts to include crime, health, and vital statistics data. The prevalence and incidence of recidivism should continue to be evaluated using a marker for an index case vs. a recidivism case. Other measures of cost should be included in all FI research to inform policy makers about how money is spent. Large scale studies of intervention programs are needed to determine what community factors influence their success or failure. FI research is limited to piecing together data from various government agencies as there is no one data source. This database should include data on perpetrators of FI, the FI itself, and the victims of FI as well as an identifier to link events over time. Given that the weapon used was unspecified in 68% of the records, better sources of data are needed than relying on ICD codes.

In conclusion, FI is a disease affecting primarily young Black males in Maryland, mostly from Baltimore City. To fully understand the disease a registry linking hospitalizations, deaths, and crime data is needed. Funding of intervention programs like hospital-based programs and community programs is more important as the number of firearm related crimes have increased since 2014 (figure 1.1), which may

indicate that more government and hospital money is being spent to treat the disease than to prevent it.

APPENDIX A: Institutional Review Board Approval

University of Maryland, Baltimore
Institutional Review Board (IRB)
Phone: (410) 706-5037
Fax: (410) 706-4189
Email: hrpo@umaryland.edu

APPROVAL OF RESEARCH NOTIFICATION

Date: December 9, 2016

To: Mary Johantgen
RE: HP-00071774
Type of Submission: Initial Review
Type of IRB Review: Expedited

Approval for this project is valid from 12/8/2016 to 12/7/2017

This is to certify that the University of Maryland, Baltimore (UMB) Institutional Review Board (IRB) approved the above referenced protocol entitled, "*Firearm Injuries in Maryland, 2006-2015: Trends and Recidivism*".

The IRB has determined that this protocol qualifies for expedited review pursuant to Federal regulations 45 CFR 46.110, 21 CFR 56.110, & 38 CRF 16.110 category(ies):
(5) - Research involving materials (data, documents, records, or specimens) that have been collected for any purpose, or will be collected solely for non-research purposes.

The IRB made the following determinations regarding this submission:
- Subpart D Determination for research involving children: 45 CFR 46.404/21CFR 50.51.
- A waiver of consent has been approved per 45 CFR 46.116(d).
- A waiver of parental permission has been approved per 45 CFR 46.116(d).
- A waiver of assent has been approved per 45 CFR 46.116(d) / 21 CFR 50.55(d).
- A waiver of HIPAA authorization for release of the PHI identified in the CICERO application has been reviewed and approved for this research study.

Below is a list of the documents attached to your application that have been approved:
Eligibility Checklist for HP-00071774 v9-10-2016-1473560918306
References for Literature Review
Variable List.docx

In conducting this research you are required to follow the requirements listed in the INVESTIGATOR MANUAL. Investigators are reminded that the IRB must be notified of any changes in the study. In addition, the PI is responsible for ensuring prompt reporting to the IRB of proposed changes in a research activity, and for ensuring that such changes in approved research, during the period for which IRB approval has already been given, may not be initiated without IRB review and approval except when necessary to eliminate apparent immediate hazards to the subject (45 CFR 46.103(4)(iii)). The PI must also inform the IRB of any new and significant information that may impact a research participants' safety or willingness to continue in the study and any unanticipated problems involving risks to participants or others.

DHHS regulations at 45 CFR 46.109 (e) require that **continuing review** of research be conducted by the IRB at intervals appropriate to the degree of risk and **not less than once per year.** The regulations make **no provision for any grace period extending the conduct of the research beyond 12/7/2017.** You will receive continuing review email reminder notices prior to this date; however, it is your responsibility to submit your continuing review report in a timely manner to allow adequate time for substantive and meaningful IRB review and assure that this study is not conducted beyond **12/7/2017**. Investigators should submit continuing review reports in the electronic system at least six weeks prior to this date.

Research activity in which the VA Maryland Healthcare System (VAMHCS) is a recruitment site or in which VA resources (i.e., space, equipment, personnel, funding, data) are otherwise involved, must also be approved by the VAMHCS Research and Development Committee prior to initiation at the VAMHCS. Contact the VA Research Office at 410-605-7000 ext. 6568 for assistance.

The UMB IRB is organized and operated according to guidelines of the International Council on Harmonization, the United States Office for Human Research Protections and the United States Code of Federal Regulations and operates under Federal Wide Assurance No. FWA00007145.

If you have any questions about this review or questions, concerns, and/or suggestions regarding the Human Research Protection Program (HRPP), please do not hesitate to contact the Human Research Protections Office (HRPO) at (410) 706-5037 or HRPO@umaryland.edu.

University of Maryland, Baltimore
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APPROVAL OF RESEARCH NOTIFICATION

Date: March 13, 2017

To: Mary Johantgen
RE: HM-HP-00071774-2
Protocol Version and ID #: N/A
Type of Submission: Modification
Type of IRB Review: Expedited
Modification request dated: 3/8/2017

Modification Approval Date: 3/13/2017
Approval for this project is valid until 12/7/2017

This is to certify that the University of Maryland, Baltimore (UMB) Institutional Review Board (IRB) approved the above referenced modification request for the protocol entitled, "*Firearm Injuries in Maryland, 2006-2015: Trends and Recidivism*".

The IRB approved this modification via expedited review pursuant to Federal regulations 45 CFR 46.110(b)(2)/21 CFR 56.110(b)(2).

The IRB made the following determinations regarding this submission:
- Subpart D Determination for research involving children: 45 CFR 46.404/21CFR 50.51.
- A waiver of consent has been approved per 45 CFR 46.116(d).
- A waiver of parental permission has been approved per 45 CFR 46.116(d).
- A waiver of assent has been approved per 45 CFR 46.116(d) / 21 CFR 50.55(d).
- A waiver of HIPAA authorization for release of the PHI identified in the CICERO application has been reviewed and approved for this research study.

Below is a list of the documents attached to your application that have been approved:
Eligibility Checklist for HP-00071774_2 v3-5-2017-1488751085442
References for Literature Review
Variable List_HSCRC.docx

In conducting this research you are required to follow the requirements listed in the INVESTIGATOR MANUAL. Investigators are reminded that the IRB must be notified of any changes in the study. In addition, the PI is responsible for ensuring prompt reporting to the IRB of proposed changes in a research activity, and for ensuring that such changes in approved research, during the period for which IRB approval has already been given, may not be initiated without IRB review and approval except when necessary to eliminate apparent immediate hazards to the subject (45 CFR 46.103(4)(iii)). The PI must also inform the IRB of any new and significant information that may impact a research participants' safety or willingness to continue in the study and any unanticipated problems involving risks to participants or others.

Research activity in which the VA Maryland Healthcare System (VAMHCS) is a recruitment site or in which VA resources (i.e., space, equipment, personnel, funding, data) are otherwise involved, must also be approved by the VAMHCS Research and Development Committee prior to initiation at the VAMHCS. Contact the VA Research Office at 410-605-7000 ext. 6568 for assistance.

The UMB IRB is organized and operated according to guidelines of the International Council on Harmonization, the United States Office for Human Research Protections and the United States Code of Federal Regulations and operates under Federal Wide Assurance No. FWA00007145.

If you have any questions about this review or questions, concerns, and/or suggestions regarding the Human Research Protection Program (HRPP), please do not hesitate to contact the Human Research Protections Office (HRPO) at (410) 706-5037 or HRPO@umaryland.edu.

University of Maryland, Baltimore
Institutional Review Board (IRB)
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APPROVAL OF RESEARCH NOTIFICATION

Date: December 5, 2017

To: Mary Johantgen
RE: HCR-HP-00071774-1
Type of Submission: Continuing Review
Type of IRB Review: Expedited

Approval for this project is valid from 12/4/2017 to 12/3/2018

This is to certify that the University of Maryland, Baltimore (UMB) Institutional Review Board (IRB) approved the continuing review report for the above referenced protocol entitled, "*Firearm Injuries in Maryland, 2006-2015: Trends and Recidivism*".

The IRB has determined that this protocol qualifies for expedited review pursuant to Federal regulations 45 CFR 46.110, 21 CFR 56.110, & 38 CRF 16.110 category(ies):
(5) - Research involving materials (data, documents, records, or specimens) that have been collected for any purpose, or will be collected solely for non-research purposes.

45 CFR 46.404/21 CFR 50.51 - The research presents no greater than minimal risk to the children.

The IRB made the following determinations regarding this submission:
- Subpart D Determination for research involving children: 45 CFR 46.404/21CFR 50.51.
- A waiver of consent has been approved per 45 CFR 46.116(d).
- A waiver of parental permission has been approved per 45 CFR 46.116(d).
- A waiver of assent has been approved per 45 CFR 46.116(d) / 21 CFR 50.55(d).

This study is approved to enroll 14000 local participants.

This study is approved to enroll 14000 worldwide participants.

Below is a list of the documents attached to your application that have been approved:
Eligibility Checklist for HP-00071774_2 v3-5-2017-1488751085442
References for Literature Review
Variable List_HSCRC.docx

In conducting this research you are required to follow the requirements listed in the INVESTIGATOR MANUAL. Investigators are reminded that the IRB must be notified of any changes in the study. In addition, the PI is responsible for ensuring prompt reporting to the IRB of proposed changes in a research activity, and for ensuring that such changes in approved research, during the period for which IRB approval has already been given, may not be initiated without IRB review and approval except when necessary to eliminate apparent immediate hazards to the subject (45 CFR 46.103(4)(iii)). The PI must also inform the IRB of any new and significant information that may

impact a research participants' safety or willingness to continue in the study and any unanticipated problems involving risks to participants or others.

DHHS regulations at 45 CFR 46.109 (e) require that **continuing review** of research be conducted by the IRB at intervals appropriate to the degree of risk and **not less than once per year.** The regulations make **no provision for any grace period extending the conduct of the research beyond 12/3/2018.** You will receive continuing review email reminder notices prior to this date; however, it is your responsibility to submit your continuing review report in a timely manner to allow adequate time for substantive and meaningful IRB review and assure that this study is not conducted beyond **12/3/2018**. Investigators should submit continuing review reports in the electronic system at least six weeks prior to this date.

Research activity in which the VA Maryland Healthcare System (VAMHCS) is a recruitment site or in which VA resources (i.e., space, equipment, personnel, funding, data) are otherwise involved, must also be approved by the VAMHCS Research and Development Committee prior to initiation at the VAMHCS. Contact the VA Research Office at 410-605-7000 ext. 6568 for assistance.

The UMB IRB is organized and operated according to guidelines of the International Council on Harmonization, the United States Office for Human Research Protections and the United States Code of Federal Regulations and operates under Federal Wide Assurance No. FWA00007145.

If you have any questions about this review or questions, concerns, and/or suggestions regarding the Human Research Protection Program (HRPP), please do not hesitate to contact the Human Research Protections Office (HRPO) at (410) 706-5037 or HRPO@umaryland.edu.

APPENDIX B: Literature Table

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
Klein, Kanno, Gilmore, & Wilson[8]	1991	Retrospective review of patient and calculated financial data from two discontinuous 1 year time intervals at a level 1 metropolitan trauma center	Harbor-UCLA Medical Center for 1986 and 1988	1,160 patients with trauma in 1986 and 1,213 in 1988	Type of injury	Intentional penetrating (firearm and stab) trauma requiring admission (Overall)	1986 - 27%		
							1988 -25%		
						Firearm injury	1986 - 30%		
							1988 - 59%		
						Repeat victims	1986 - 3%		
							1988 - 6%		
						Mortality (Overall)	4.70%		
						Required Truncal Procedure	1986 - 71%		
							1988 - 80%		
					Length of Stay (days)	Firearm	1986 - 6.7		
							1988 - 7.0		
					Payment	None	81%		
						Private	5%		
					Charges	Total	$2,481,346		
						Per patient	$4,423		
						Firearm Injured	$5,260		
						Percent Collected	22%		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
Ryan, Leighton, Pianim, Klein, & Bongard[6]	1993	Investigated how much violent injury results from firearms in a one year period and match with law enforcement records to determine if gang related and the economic consequences.	Patients admitted to Harbor-UCLA Medical Center in Los Angeles from May 1988 through April 1989.	191 firearm related admissions, 56% gang related.	Demographics	Males	92%		
						Age	23 ± 7 years		
						Black	55%		
						Hispanic	24%		
					Presented	7 pm - 7 am	86%		
					Surgical Procedures	Abdomen	36%		
						Thoracotomy	5%		
						Neck and Extremity	14%		
						Multiple Procedures	37%		
					Charges	Surgical (total)	$480,000		
						Inpatient Charges (total)	$878,867		
						Critical Care Charges (total)	$718,740		
						Hospital (total)	Near $2 million		
					Financial Status	Indigent	88%		
						Disability after discharge	70%		
Kellerman et al.[16]	1996	Descriptive study of records of the police, medical examiners, ambulance crews, and hospital emergency departments and	Firearm injuries of 1915 cases of injury due to firearms were identified between November 16,	Rates for blacks and Hispanics compared to non-Hispanic whites adjusting for age and sex	Memphis	Rate (per 100,000)	223		
					Seattle	Rate	54		
					Galveston	Rate	144		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
		hospital admissions were monitored to identify all injuries caused by firearms that were severe enough to prompt emergency medical treatment.	1992, and May 15, 1994 in Memphis, TN, Seattle, WA, and Galveston, TX.	were 13.5 and 2.6, respectively. Males were shot 8.2 times as often as females. Rates sharply rose from age 10, peaking between ages 20 to 29, then declining.	Overall	Assault	78%		
						Suicide	7%		
						Unintentional	5%		
						Handguns	89%		
						DOA	4%		
						ED Discharge	59%		
						Hospitalized	35%		
						ED Charges (median)	$538		
						Inpatient Charges (median)	$10,050		
Cook, Lawrence, Ludwig & Miller[7]	1999	Cost analysis of discharge data from Maryland for 1994-1995 and New York for 1994 and from emergency departments in South Carolina for 1997. Other sources include the National Electronic Injury Surveillance System for 1994 incidence of nonfatal gun injuries, the National Spinal Cord Injury Statistical Center	Any patient with a gunshot injury in the United States		Incidence	Total	134,445 (95% CI, 109,465-159,425)		Total lifetime costs based on Acute Care Costs, Hospital Readmissions, 6-month Ancillary and Follow-up Costs, and Claims Administration Costs.
						Assault	91,273 (66,772-115,774)		
						Un-intentional	17,458 (13,973-20,943)		
						Self-Inflicted	25,714 (22,319-29,109)		
					Medical Costs	Mean cost per injury	$17,000		
						Total lifetime	$2.3 Billion		
						Assault	$1.7 Billion		
						Unintentional	$0.4 Billion		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
		database for 1988-1992 estimates of lifetime medical costs of gun injuries and the 1994 Vital Statistics census for incidence of fatal gun injuries.				Self-Inflicted	$0.2 Billion		
						Paid by taxpayer	49%		
						Caused by assaults	74%		
Coben & Steiner[9]	2003	Cross-sectional analysis of the 1997 Nationwide Inpatient Sample (NIS). Firearm injuries were identified using E codes. For each identified firearm-related case, the following variables were extracted: age, gender, median household income for patient's ZIP code (per 1990 census data), principal diagnosis, principal procedures, number of procedures, major diagnosis category, length of stay, in-	Sample of 1012 nonfederal community hospitals from 22 states	A total of 7573 cases were identified in the NIS database. When weighted, these represent an estimated 35,810 (CI 32,615–38,947) firearm-related hospital discharges nationwide in 1997	Demographics	Males	86%		
						Ages 15-19	21.30%		
						Ages 20-24	21%		
						Ages 40 or more	19.60%		
					Type of injury	Assault	52%		
						Unintentional	31%		
						Self-Inflicted	8%		
					Disposition	Routine	75%		
						Other type of facility	7%		
						Home health care	5%		
						Died	7%		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
		hospital death, disposition of patient, expected primary payer, hospital charges, admission day of week, admission month, hospital region, bed size of hospital, control/ownership of hospital, and location/teaching status of hospital.			Length of Stay (days)	Assault	Median - 2.8		
						Unintentional	2.4		
						Self-Inflicted	3.1		
						Legal Intervention	3.5		
					Charges	Per patient	Median		
						Assault	12,126		
						Unintentional	8,866		
						Self-Inflicted	14,430		
						Legal Intervention	14,224		
					Sum of Charges	Total	$802,270,788		
					Payer	Self-pay	29%		
						Medicaid	25%		
						Private	25%		
Carlson[31]	2006	A study of self-reported violence exposure, mental health symptoms, aggressive behaviors, self-concept, attitudes toward guns and violence, levels and types of parental monitoring in sample of rural youth.	Respondents m this survey were recruited by school personnel at middle and high schools in two rural counties in southeast Ohio; participating schools included two middle schools, one high school, and a	Average age was 15.3, with a range from 11 to 19.There were 260 (54.5 percent) girls and 216 (45.3 percent) boys, with students being predominately white (95 percent), reflecting the ethnicity in this rural area.	Violence Exposure		Sometimes or greater		Self-reported data, subject to over- and underreporting, possibly limiting internal validity.
						School	Slapped, hit, punched or beaten up - 33%		
						Neighbor-hood	Slapped, hit, punched or beaten up - 34%		
						Home	Slapped, hit, punched or beaten up - 38%		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
			nontraditional vocational technical high school.	Most students in the sample reported that they lived with their mother and father (62.9 percent).		Gun Violence -	Shot or shot at - 8%		
							Gun pointed at you - 10%		
					Linear Modeling	For carrying a gun	Adjusted R^2=.024		
						Gender	B = 0.155		
						Poverty Rate	B = .127		
Corso et al.[27]	2006	Describe the national incidence, medical costs, and productivity losses of medically treated injuries. Combined the Medical Expenditure Panel Survey, Healthcare Cost and Utilization Project – Nationwide Inpatient Sample, and National Vital Statistics System to estimate the incidence of fatal and non-fatal injuries in 2000. Comparisons made to 1985 estimates from	50 million medically treated injuries		Incidence for Firearm/ Gunshot	Fatal	28,722		Use myriad data sources, each with limitations. Some sources were old, others were based on non-nationally representative samples, and all were subject to reporting and measurement error. These limitations not only increase the lack of precision around the estimates, but may result in additional bias.
						Fatal; Rate per 100,000	10		
						Total Firearm	131,013		
						Rate per 100,000 in 2000	47		
						Rate per 100,000 in 1985	130		
						Rate per 100,000 for Males Age 5-14 in 2000	143		
						Rate per 100,000 for	72		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
		report to Congress.				Males Age 5-14 in 1985			
						Rate per 100,000 for Males Age 15-24 in 2000	197		
						Rate per 100,000 for Males Age 15-24 in 1985	220		
					Costs (in millions) for Firearm/ Gunshot	Medical Costs	$1,225		
						Productivity Losses	$35,226		
						Total Costs	$36,451		
					Likelihood of Firearm Injury	Males	9 times more likely		
Boyle & Hassett-Walker[26]	2008	Emergency Department (ED) staff at the six hospitals providing emergency medical care within the city collected data on all assault-related ED visits. Multi-level analysis conducted using individual-level and neighborhood-level characteristics (US Census, 2000) with rates	1,204 assault (all assaults) related ED visits from 6 Newark, NJ hospitals for February, April, August, and October of 2001.	Men were more likely to be injured with a firearm than women (χ^2=25, p≤.001).	Offender	Current or former spouse	Male = 3.9%		
							Female = 15.9%		
						Parent or Guardian	Male = 1.6%		
							Female = 1.6%		
						Other Family Member	Male = 3.7%		
							Female = 5.8%		
						Friend or Acquaintance	Male = 9.9%		
							Female = 12.2%		
						Stranger	Male = 18%		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
		of assault-related injuries.					Female = 12.2%		
						Police Officer	Male = 4.8%		
							Female = 0.6%		
						Gang or Group	Male = 12.6%		
							Female = 1.9%		
					Race	African American	77.50%		
						White	4.50%		
						Hispanic	14.20%		
					Assault injury rate regressed on socio-structural predictors	R^2	0.24		
						Poverty Concentration	Beta = .40, p<.001		
						Percentage of Vacant Housing Units	Beta = .26, p<.001		
					GIS	Level 1 Trauma Center	82% of Cases		
Velis, Shaw & Whiteman[22]	2010	Cross-sectional study of homicide victims' characteristics in Miami-Dade County and Broward County between 2004 and 2007.	Miami-Dade and Broward counties Medical Examiners' offices, the U.S. Census Bureau, and the Federal Bureau of Investigation.	Between 2004 and 2007, the total number of homicide victims in both Miami-Dade County and Broward County combined during the selected four-year period was 1267; an average of 317 deaths per year	Homicide Rate	From 2004 - 2007	Increased by 36%		
					Risk of dying by homicide	From 2004 - 2007	Increased by 18% in Miami-Dade County		
							Increased by almost 50% in Broward County		
					Homicide Proportions	Males	80% of all victims		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
				with a homicide crude rate for both counties around 15 deaths per 100,000 population; 71% of homicides across the two counties of occurred in Miami-Dade County.		Blacks	56% of homicide victims		
						Mean age	Miami-Dade 34 years		
						Ages 14-17	Increased to 7.5% from 3.4%.		
						Younger than 25 years	30%		
					Cause of Homicide	Firearm Injury	75%		
					Firearm Death	Black	63%		
					Correlation	Homicide rates and the proportion of adult individuals, 25 years and older, with high school or higher education	$r = -.67$, $p < .01$		
						Poverty and risk of homicide	$r = .56$, $p < .01$		
						Unemployment rate and risk of homicide	$r = .54$, $p < .01$		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
Newgard et al.[15]	2011	Secondary analysis of an out-of-hospital, consecutive patient, prospective cohort registry of injured children and adults evaluated by EMS agencies and meeting field criteria for major trauma. We used an ecological study design to assess the association between rates of major injury events and population sociodemographic factors at the locations where injuries occurred. A total of 163 primary (first-arriving) EMS agencies transporting patients to 177 acute care hospitals in 9 cities or counties across the United States and Canada gathered population-based data from	Injured children and adults requiring activation of the emergency 911 system within predefined geographic regions across each site. To be included in the cohort, patients were required to have received an EMS evaluation and to have met field-based criteria for major trauma, defined by the presence of physiological compromise at any point during the out of hospital evaluation (systolic blood pressure level of 90 mmHg or below, respiratory rate of less than 10 or more than 29 breaths per minute,	EMS systems at the 9 study sites evaluated 8328 major trauma patients during the 16-month study period. After exclusions, 7326 major trauma patients were included for analysis.	Demographics	Died in field	14%		
						Penetrating injuries	18.80%		
						Intentional injuries	24%		
					Census Tracts	Higher than expected incidence	14%		
					Clustering Model for Penetrating Injury		Clustering occurred in 335 census tracts. The differences between those with clustering and without are shown		
						Non-White %	18%		
						Un-employment rate	5%		
						Income > $100,000	-11.70%		
						High school diploma	-11.40%		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
		December1, 2005, through April 30, 2007. Analyzed 4 models defined according to outcome: major trauma, death in the field, penetrating injury, and intentional injury.	Glasgow Coma Scale score of 12 or less, field advanced airway attempt such as intubation, or traumatic death in the field).						
Corbin, Purtle, L. Rich, J. Rich, Adams, Yee, & Bloom[17]	2013	A cross- sectional analysis of violently injured individuals (a group that did not include cases of domestic or sexual violence) that had presented to the ED	191 violently injured patients at a level 1 trauma center in a major US city	Median age 22 Male 91% African American 80% Firearm Injury 71% Prior violence 48.5%	PTSD Prevalence	Full criteria	75%		Adverse childhood experiences are divorce, household member incarcerated, substance abuser in the home, and abuse - emotional or physical, neglect.
						Re-experiencing	91%		
						Arousal	87.50%		
						Avoidance	81.30%		
					Adverse Childhood Experiences	2 Events	81%		
						4 Events	50%		
						6 Events	22%		
						8 or more events	6%		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
Burgason, Thomas, & Berthelot[30]	2014	Examines variations in violence by assessing the incident and contextual-level predictors of offender gun use and physical injuries sustained by victims of robbery and aggravated assault using data from the National Incident Based Reporting System in conjunction with data from the American Community Survey using hierarchical generalized estimating equations.	Individuals from cities with 100,000 or more residents.	25,340 aggravated assaults 12,272 robberies Total of 37,612 incidents 43 large U.S. cities	Demographics	Gun Use	Approximately 31% of aggravated assaults and Robberies		Results suggest incidents involving guns are relatively more prevalent in cities with high levels of socioeconomic disadvantage and violence. In addition, Blacks were found to have an increased likelihood of being victims of gun crimes. However, Black victims in disadvantaged communities do not face a greater risk of being victimized by gun wielding offenders compared with Black victims in more affluent communities. Does not include some large cities as they do not participate in NIBRS
					Multilevel predictors that victim is injured	Events result in injury	55%		
						Black Victim	64%		
						Black victims	0.148		
						Males	0.501		
						Younger	0.168		
						Offender Intoxicated	0.717		
						Attacked in home	0.414		
						Gun Use and Black Male	0.641		
						Socioeconomic Disadvantage	NS		
						Gun Use, Black Male, & Disadvantage	-1.9		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
									including Chicago, Los Angeles and New York.
Kalesan et al.[28]	2014	Document overall trends in firearm related hospitalizations (FRH) and rates of cause-, gender- and race-specific FRHs, as well as determine any differential in the risk of in-hospital mortality due to FRHs according to demographic characteristics.	Data for 3,257,720 hospitalizations from the National Hospital Discharge Survey (2000–2010)	1,545 FRH identified	Rates per 100,000 hospitalizations	Overall	57.28		Risk of mortality remained high in all subgroups based on gender, age, race, marital status, and region and did not show significant interactions across strata.
						Overall White	33.48		
						Overall Black	208.9		
						Lowest Year	2009 - 38.57		
						Highest Year	2003 - 70.32		
						Highest Intent	Assault - 30.67		
						Lowest Intent	Attempted Suicide - 2.93		
					Annual Trends	Overall	-1.38	0.63	
						Assault	-0.42	0.25	
						Suicide	-0.45	0.58	
						Hospitalized	-0.4	0.59	
						Men	-3.21	0.9	
						Whites	-1.31	0.47	
						Blacks	-7.03	0.55	
					Length of Stay	Non FRH	4.75		
						FRH	4.81		
					Diagnoses	Internal Injury to Thorax,	20.10%		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
						Abdomen, or Pelvis			
						Fracture Lower Extremity	16.30%		
						Open Wound of Head, Neck, or Trunk	12.10%		
						Open Wound of Lower Limb	11.70%		
					Surgical Procedures	Operation of Musculo-skeletal System	24%		
						Diagnostic or Therapeutic Procedure	16%		
						Operation Digestive System	14%		
						Operation Skin	10%		
						No Major Procedure	17%		
						Operation Nervous System	3%		
					In-hospital mortality Risk	FRH	3.62		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
Lee et al.[5]	2014	Analysis of the Nationwide Inpatient Sample (NIS), the National Emergency Department Sample (NEDS), and the Kid Inpatient Database (KID) from 2006 to 2010 for all hospital and emergency department (ED) discharges for firearm-related injuries to estimate the annual incidence of firearm-related injuries. The cost of direct medical services and lost productivity from firearm-related injuries were extrapolated from recently published estimates. To identify potentially important trends, we compared the economic impact and payor mix for	Nationally representative sample from 20% of US hospitals.	From 2006 through 2010, there were 385,769 (SE = 29,328) firearm-related ED visits resulting in 141,914 (SE = 14,243) hospital admissions. During this period, 243,856 (SE = 16,677) were seen, evaluated, and were discharged from the ED without need for hospital admission.	Hospital Visits	All	2006 – 6.65 per 10,000		Differences for hospital rates and Payor between 2006 and 2010 were significantly different, $p < .001$.
							2010 – 5.76 per 10,000		
						Admitted to the hospital	2006 – per 10,000		
							2010 – 1.96 per 10,000		
						Discharged from the ED	2006 – 4.08 – per 10,000		
							2010 – 3.79 per 10,000		
					Costs	Total	2006 – $18,622,721,416		
							2010 – $16,984,527,276		
						Admitted to the hospital	2006 – $12,847,660,657		
							2010 – $10,968,347,046		
						Discharged from the ED	2006 – $5,775,060,758		
							2010 – $6,016,180,230		
					Payor	Uninsured	2006 – 51.60%		
							2010 – 46.78%		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
		firearm-related injuries in 2006 with those in 2010				Medicare/ Medicaid	2006 – 25.71% 2010 – 31.25%		
						Private	2006 – 22.69% 2010 – 21.97%		
Livingston, R. Lavery, Lopreiato, D. Lavery, & Passannante[21]	2014	Retrospective review of all patients treated for firearm injuries from January 1, 2000, until December 31, 2011.	Patients who sustained GSW secondary to interpersonal violence treated at New Jersey Trauma Center at University Hospital in Newark, New Jersey. Patients were excluded if they sustained self-inflicted injuries, were injured by law enforcement, or sustained injury from BB or pellet guns	6,322 patients were patients of interpersonal firearm violence and are the study population of interest. Ninety-eight percent were injured by handguns. The mean number of patients treated was 527 per year (range, 389Y640).	Demographics	Males	92%		
						Blacks	86%		
						Ages 20-29	50%		
					Incidence	3 or more wounds	Increased from 10% to 23%		
						Newark and Irvington	100 injuries per 100,000 annually		
					Mortality	Overall	11%		
						From 2001 to 2011	Increased from 9% to 14%		
					Surgical Procedures	at least 1	75%		
					Hierarchical logistic regression for mortality		Correctly predicted 93% of discharge status		
						Older patients	OR, 1.03, 95% CI, 1.01-1.04		
						Blood units administered	OR 1.04; 95% CI, 1.03-1.05		
						Head AIS score	OR 2.64; 95% CI, 2.46-2.83		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
						Chest AIS score	OR 2.17; 95% CI, 2.04-2.31		
						Abdominal AIS score	OR 1.39; 95% CI, 1.03-1.55		
						Multiple wounds	OR 1.11; 95% CI, 1.06-1.17		
					Cluster Analysis	2 or more patients arriving with 15 minutes of each other	Increased from 8% to 28% from 2001 to 2011		
						3 or more patients	Increased from 1% to 16%		
						Timing of arrival	Peak 4pm to midnight		
					Length of Stay	ICU	Median - 3		
						Hospital	Median - 5		
					Resources	Ventilator Days	Median - 1		
						Units of Blood	Median - 8		
					Costs	Total	$115 million		
						Amount collected	25%		
					Distances	Home to scene of event	1.92 miles		
						Home to Trauma Center	90% fell within 6 miles		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
Loder[29]	2014	Emergency department visits associated with firearm use were analyzed for month and day of the week for various demographic variables.	Inter-University Consortium for Political and Social Research Firearm Injury Surveillance Study 1993-2008 (ICPSR 30543)10 collected by the National Electronic Injury Surveillance System (NEISS).	61,419 firearm injuries in the ICPSR data base between 1993 and 2008, resulting in an estimated 1,841,269 injuries.	Time of firearm events	During the Year	The majority of the peaks were in late summer and autumn. Nearly all the self-inflicted injuries occurred in the autumn months regardless of subgroup, those by strangers in the late summer/early autumn, and in the summer when the perpetrator was not seen.		
						Day of week	The overall peak day was on the weekend, usually at 2400 Saturday/0000 Sunday		
						Admitted to the hospital for injuries associated with a firearm	The tallest Peak on Saturday/Sunday in October/ November with 10,377 patients, but also with 2 other peaks Saturday in January, and Saturday/Sunday in May/June		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
Rowhani-Rahbar et al.[12]	2015	Retrospective cohort study comparing risk for subsequent violent injury, death, or crime perpetration among patients with an FRH, those hospitalized for noninjury reasons, and the general population.	Patients with an FRH and a random sample of those with a non–injury-related hospitalization in 2006 to 2007 (index hospitalization) in all hospitals in Washington.	There were 77 138 index injury-related hospitalizations in 2006 to 2007. Of these, 9048 (11.7%) were due to a violent injury, including hospitalizations related to firearms (n = 680), nonfirearm assaults (n = 2526), and nonfirearm self-inflicted injuries (n = 5842). We also studied 180 841 patients with an index hospitalization that was not injury-related.	Hazard ratio for firearm related hospialization	Firearm	21.2 (7.0–64.0)		
						Nonfirearm assault	3.1 (0.9–10.3)		
						Nonfirearm self-inflicted	0.8 (0.1–5.8)		
						Nonviolent injury	1.7 (0.8–3.8)		
						Noninjury	Reference		
					Hazard ratio for firearm related arrest or violent crime arrest	Firearm	2.7 (2.0–3.5)		
						Nonfirearm assault	2.0 (1.7–2.4)		
						Nonfirearm self-inflicted	2.4 (2.1–2.8)		
						Nonviolent injury	1.4 (1.3–1.6)		
						Noninjury	Reference		
					Hazard ratio for firearm related death	Firearm	4.3 (1.3–14.1)		
						Nonfirearm assault	0.7 (0.2–2.7)		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
						Nonfirearm self-inflicted	4.1 (2.3–7.3)		
						Nonviolent injury	1.4 (1.0–1.9)		
						Noninjury	Reference		
Fowler, Dahlberg, Haileysus, & Annest[23]	2015	Cross-sectional	National Vital Statistics and National Electronic Injury Surveillance Systems	Age, gender, race/ethnicity,	Rates of fatal and non-fatal rates, location of events, injury characteristics, healthcare response, costs	Fatal Annual FI Rates	10.2 per 100,000		
						Males	18.1 per 100,000		
						Females	2.8 per 100,000		
						Black	18.1 per 100,000		
						White	9.8 per 100,000		
						Hispanic	5.7 per 100,000		
						Non-fatal FI Rates	21.6 per 100,000		
						Males	38.4 per 100,000		
						Females	4.6 per 100,000		
						Medical and work loss costs	48 billion		
						Fatal	44 billion		
						Non-fatal	4 billion		
Cook et al[70]	2017	Cross-sectional	National Electronic Injury Surveillance System		Case-fatality rate	2003	22%		Adjusted the estimates for discontinuities created by the substitution of 1 hospital for another in the sample and for a downward trend in the percentage of gunshot injuries classified as "unknown circumstance."
						2012	22%		

Author	Year	Study Design	Study Population	Patient Characteristics	Outcome		Results	Effect Size	Comments
Kalesan et al[24]	2017	Cross-Sectional	National Electronic Injury Surveillance System–All Injury Program and CDC's Wide-ranging Online Data for Epidemiologic Research 1,328,109 individuals who sustained firearm injuries between 2001 and 2013	age, sex, race/ ethnicity, and intent of injury	Rates of fatal and non-fatal FI	Rate of Injury White Fatal Nonfatal Black Fatal Nonfatal Hispanic Fatal Nonfatal	2001 2006 2013 16.9 18.0 20.4 9.4 9.2 11.0 7.5 8.8 9.3 92.6 98.3 86.8 19.1 21.0 17.8 73.4 77.3 68.9 31.6 35.7 30.3 8.5 8.0 5.6 23.1 27.8 24.7		
Gross et al[25]	2017	Cross-Sectional	Pennsylvania Trauma Outcome Study, 462,081 patients	Intent and type of firearm, race, age, gender	Mortality, rates of hospitalization, functional status	GSW Handgun Assaults Admission year	4.2% of total patients 86.7% 79.7% Not associated with improved survival or functional status		

APPENDIX C: Multivariate Analysis of Individual Characteristics and Disadvantage using GEE

	B	SE	Exp(B)	Low CI	High CI
Intercept	-4.26	.69	.01	.00	.05
Female	-0.99	.54	.37	.13	1.08
Male					
Other	-0.24	1.15	.79	.08	7.43
Black	1.50*	.62	4.48	1.33	15.10
White					
Self-Pay	0.30	.23	1.35	.86	2.12
Medicaid	1.10*	.47	2.99	1.19	7.53
Medicare	0.01	.25	1.01	.62	1.66
Private					
Tobacco	-0.37*	.20	.69	.47	1.01
age	-0.03**	.01	.97	.96	.99
Disadvantaged	0.33***	.08	1.39	1.18	1.64
Percent Black	0.11	.09	1.12	.94	1.34

AUROC = .69, Cox and Snell R square =.01, Nagelkerke R square =.04

APPENDIX D: National Network of Hospital-based Violence Intervention Programs Services

National Network of Hospital-based Violence Intervention Programs Technical Assistance Services

Item	Price	Notes	# of trainers
On site trainings:			
2-day at trainer program site	$3,000		2 to 3
3-day at trainer program site	$4,100		2 to 3
1-day at *trainee* program site	$2,400	plus travel & lodging	1 to 2
2-day at *trainee* program site	$3,800	plus travel & lodging	2
3-day at *trainee* program site	$4,900	plus travel & lodging	2
1 page post-visit memo	$0	included	1
Pre-visit phone call & agenda prep	$0	included	1
5 page post-visit program review	$1,500		1
Skype/phone call trainings:			
90 minute training modules (see below)	$250	each	1
Program consultations	$80	per 60 minute call (first call is free)	
Case conferencing	$80	per 60 minute call	1
Bi-weekly phone support (for start-up, implementation, and/or supervision)	$200	per month	1
Other			
Review of written program materials	$80	per hour	1
Feedback on funding proposals	$80	per hour	1
Long-term support to develop program	TBD	Price varies, based on tasks and time	

Training modules:

- HVIP Model Overview - what it is, why it works, hospital-linked vs. based, etc.
- Developing program goals & objectives
- "Selling the program"—preparing for a presentation with key stakeholders
- Identification of the focus population (assistance with data analysis)
- Drafting Memoranda of Understanding with hospitals and/or service providers
- Conducting a program evaluation
- Hiring & training new staff
- Supporting direct service staff (avoiding burnout, supporting growth)
- Principles of Trauma Informed Care
- Practices of Trauma Informed Care
- Identification & training of a suitable nonprofit partner
- Identification of funding opportunities & feedback on grant proposals
- Development of documentation protocol
- Setting up an electronic database (link with database consultant)
- Budget development & staffing plan
- Identifying & building relationships with local resources

For more information, or to schedule a training, contact:

Linnea Ashley, Training Manager at (510) 594-2588 x314 or lashley@youthalive.org

REFERENCES

1. Planty M, Truman J. Firearm violence, 1993-2011. . 2013;NCJ 241730.

2. Truman J, Langton L. Criminal victimization, 2013. . 2014;NCJ 247648.

3. Baltimore police department open data. https://data.baltimorecity.gov/Public-Safety/BPD-Part-1-Victim-Based-Crime-Data/wsfq-mvij.

4. Kellermann A, Rivara F. Silencing the science on gun research. *JAMA: the Journal of the American Medical Association*. 2013;309(6):549-550. doi: 10.1001/jama.2012.208207.

5. Lee J, Quraishi SA, Bhatnagar S, Zafonte RD, Masiakos PT. The economic cost of firearm-related injuries in the united states from 2006 to 2010. *Surgery*. 2014;155(5):894-898. http://search.ebscohost.com/login.aspx?direct=true&db=cmedm&AN=24684950&site=eds-live. doi: 10.1016/j.surg.2014.02.011.

6. Ryan M, Leighton T, Pianim N, Klein S, Bongard F. Medical and economic consequences of gang-related shootings. *Am Surg*. 1993;59(12):831-833. http://search.ebscohost.com/login.aspx?direct=true&db=cmedm&AN=8256937&site=eds-live.

7. Cook, P J Lawrence, B A Ludwig, J Miller,T R. The medical costs of gunshot injuries in the united states. *JAMA: the Journal of the American Medical Association*. 1999;282(5):447-454. doi: 10.1001/jama.282.5.447.

8. Klein SR, Kanno IJ, Gilmore DA, Wilson SE. The socioeconomic impact of assault injuries on an urban trauma center. *Am Surg*. 1991;57(12):793-797. http://search.ebscohost.com/login.aspx?direct=true&db=cmedm&AN=1746796&site=eds-live.

9. Coben JS, Claudia. Hospitalization for firearm-related injuries in the united states, 1997. *Am J Prev Med*. 2003;24(1):1-8. doi: 10.1016/S0749-3797(02)00578-0.

10. Copeland-Linder N, Johnson SB, Haynie DL, Chung S, Cheng TL. Original article: Retaliatory attitudes and violent behaviors among assault-injured youth. *Journal of Adolescent Health*. 2012;50:215-220. http://survey.hshsl.umaryland.edu/?url=http://search.ebscohost.com/login.aspx?direct=true&db=edselp&AN=S1054139X11001236&site=eds-live. doi: 10.1016/j.jadohealth.2011.04.005.

11. Rich JA, Grey CM. Pathways to recurrent trauma among young black men: Traumatic stress, substance use, and the "code of the street". *Am J Public Health*. 2005;95(5):816. http://survey.hshsl.umaryland.edu/?url=http://search.ebscohost.com/login.aspx?direct=true&db=f5h&AN=16920426&site=eds-live. doi: 10.2105/AJPH.2004.044560.

12. Rowhani-Rahbar A, Zatzick D, Wang J, et al. Firearm-related hospitalization and risk for subsequent violent injury, death, or crime perpetration. *Ann Intern Med*. 2015;162(7):492-500. http://search.ebscohost.com/login.aspx?direct=true&db=hch&AN=101952452&site=eds-live. doi: 10.7326/M14-2362.

13. Thurman P. Firearm injuries and recidivism of a level 1 trauma center. .

14. Kleinbaum DG, Klein M. *Survival analysis: A self-learning text.* Third ed. New York, NY: Springer; 2012. 10.1007/978-1-4419-6646-9.

15. Newgard CD, Schmicker RH, Sopko G, et al. Trauma in the neighborhood: A geospatial analysis and assessment of social determinants of major injury in north america. *Am J Public Health*. 2011;101(4):669-677. http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=59347437&site=eds-live. doi: 10.2105/AJPH.2010.300063.

16. Kellermann, A L Rivara, F P Lee, R K Banton, J G Cummings, P Hackman,B B Somes, G. Injuries due to firearms in three cities. *N Engl J Med*. 1996;335(19):1438-1444. doi: 10.1056/NEJM199611073351906.

17. Corbin TJ, Purtle J, Rich LJ, et al. The prevalence of trauma and childhood adversity in an urban, hospital-based violence intervention program. *Journal of Health Care for the Poor & Underserved*. 2013;24(3):1021.

http://search.ebscohost.com/login.aspx?direct=true&db=edb&AN=89986829&site=eds-live.

18. Iezzoni LI. Coded data from administrative sources. In: Iezzoni LI, ed. *Risk adjustment for measuring health care outcomes.* 4th Edition ed. Chicago, IL: Health Administrative Press; 2013:95-146.

19. Sampson RJ. *Great american city: Chicago and the enduring neighborhood effect.* Chicago: The University of Chicago Press; 2012.

20. Beicher. Inner-city victims of violence and trauma care: The importance of trauma-center discharge and aftercare planning and violence prevention programs. *J Health Soc Policy*. 2005;21(2):17-34. doi: 10.1300/J045v21n02_02.

21. Livingston D, Lavery R, Lopreiato M, Lavery D, Passannante M. Unrelenting violence: An analysis of 6,322 gunshot wound patients at a level I trauma center. *The journal of trauma and acute care surgery*. 2014;76(1):2-9. doi: 10.1097/TA.0b013e3182ab19e7.

22. Velis E, Shaw G, Whiteman AS. Victim's profile analysis reveals homicide affinity for minorities and the youth. *Journal of Injury & Violence Research*. 2010;2(2):67-74. http://search.ebscohost.com/login.aspx?direct=true&db=sih&AN=58149020&site=eds-live. doi: 10.5249/jivr.v2i2.50.

23. Fowler KA, Dahlberg LL, Haileyesus T, Annest JL. Firearm injuries in the united states. *Prev Med*. 2015.

http://search.ebscohost.com/login.aspx?direct=true&db=edselp&AN=S0091743515001991&site=eds-live. doi: 10.1016/j.ypmed.2015.06.002.

24. Kalesan B, Adhikarla C, Pressley JC, et al. The hidden epidemic of firearm injury: Increasing firearm injury rates during 2001-2013. *Am J Epidemiol*. 2017;185(7):546-553. http://survey.hshsl.umaryland.edu/?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=122315764&site=eds-live. doi: 10.1093/aje/kww147.

25. Gross BW, Cook AD, Rinehart CD, et al. An epidemiologic overview of 13 years of firearm hospitalizations in pennsylvania. *J Surg Res*. 2017;210:188-195. http://survey.hshsl.umaryland.edu/?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=122769191&site=eds-live. doi: 10.1016/j.jss.2016.11.021.

26. Boyle DJ, Hassett-Walker C. Individual-level and socio-structural characteristics of violence: An emergency department study. *J Interpers Violence*. 2008;23(8):1011. http://search.ebscohost.com/login.aspx?direct=true&db=edb&AN=33434274&site=eds-live.

27. Corso. Incidence and lifetime costs of injuries in the united states. *Injury prevention*. 2006;12(4):212-215. doi: 10.1136/ip.2005.010983.

28. Kalesan B, French C, Fagan J, Fowler D, Galea S. Firearm-related hospitalizations and in-hospital mortality in the united states, 2000-2010. *Am J Epidemiol*. 2014;179(3):303-312. doi: 10.1093/aje/kwt255.

29. Loder. Temporal variation in united states firearm injuries 1993-2008: Results from a national data base. *Journal of Injury and Violence Research*. 2014;6(1):1-15. doi: 10.5249/jivr.v6i1.351.

30. Burgason KA, Thomas SA, Berthelot ER. The nature of violence: A multilevel analysis of gun use and victim injury in violent interpersonal encounters. *J Interpers Violence*. 2014;29(3):371. http://search.ebscohost.com/login.aspx?direct=true&db=edb&AN=93384480&site=eds-live.

31. Carlson KT. Poverty and youth violence exposure: Experiences in rural communities. *Children & Schools*. 2006;28(2):87. http://search.ebscohost.com/login.aspx?direct=true&db=f5h&AN=20478851&site=eds-live.

32. Mitchell CS. Injuries in maryland: 2011 statistics on injury-related emergency department visits, hospitalizations and deaths. . 2014.

33. Sweeney L. *Uniqueness of simple demographics in the US population.* ; 2000.

34. El Emam K, Buckeridge D, Tamblyn R, Neisa A, Jonker E, Verma A. The re-identification risk of canadians from longitudinal demographics. *BMC Med Inform Decis Mak*. 2011;11:46-46. http://survey.hshsl.umaryland.edu/?url=http://search.ebscohost.com/login.aspx?direct=true&db=cmedm&AN=21696636&site=eds-live. doi: 10.1186/1472-6947-11-46.

35. Groos M, Wallace M, Hardeman R, Theall K. Measuring inequity: A systematic review of methods used to quantify structural racism. *Journal of Health Disparities Research & Practice*. 2018;11(2):190-205. http://survey.hshsl.umaryland.edu/?url=http://search.ebscohost.com/login.aspx?direct=true&db=asn&AN=131446000&site=eds-live.

36. Boyd CR, Tolson MA, Copes WS. Evaluating trauma care: The TRISS method. trauma score and the injury severity score. *J Trauma*. 1987;27(4):370-8.

37. Rating the severity of tissue damage. I. the abbreviated scale. *JAMA: the Journal of the American Medical Association*. 1971;215(2):277-80. doi: 10.1001/jama.1971.03180150059012.

38. Rating the severity of tissue damage. II. the comprehensive scale. *JAMA: the Journal of the American Medical Association*. 1972;220(5):717-20. doi: 10.1001/jama.1972.03200050055013.

39. Baker SP, O'Neill B, Haddon W, Long WB. The injury severity score: A method for describing patients with multiple injuries and evaluating emergency care. *J Trauma*. 1974;14(3):187-96.

40. Palmer C. Major trauma and the injury severity score--where should we set the bar? *Annu Proc Assoc Adv Automot Med*. 2007;51:13-29. http://survey.hshsl.umaryland.edu/?url=http://search.ebscohost.com/login.aspx?direct=true&db=cmedm&AN=18184482&site=eds-live.

41. Mitchell MS, León CLK, Byrne TH, Lin W, Bharel M. Cost of health care utilization among homeless frequent emergency department users. *Psychol Serv*. 2017;14(2):193-202. http://survey.hshsl.umaryland.edu/?url=http://search.ebscohost.com/login.aspx?direct=true&db=pdh&AN=2017-19411-009&site=eds-live. doi: 10.1037/ser0000113.

42. Park a,R.E. Estimation with heteroscedastic error terms. *Econometrica*. 1966(4):888. http://survey.hshsl.umaryland.edu/?url=http://search.ebscohost.com/login.aspx?direct=true&db=edsjsr&AN=edsjsr.10.2307.1910108&site=eds-live. doi: 10.2307/1910108.

43. Li H. Disability, insurance coverage, area deprivation and health care: Using spatial analysis to inform policy decisions. *Procedia Environmental Sciences*. 2016;36:20-25. http://survey.hshsl.umaryland.edu/?url=http://search.ebscohost.com/login.aspx?direct=true&db=edselp&AN=S1878029616302067&site=eds-live. doi: 10.1016/j.proenv.2016.09.004.

44. Hamby S. On the use of race and ethnicity as variables in violence research. *Psychology of Violence*. 2015;5(1):1-7. http://search.ebscohost.com/login.aspx?direct=true&db=pdh&AN=2014-56631-001&site=eds-live. doi: 10.1037/a0038470.

45. Berg M. Accounting for racial disparities in the nature of violent victimization. *Journal of Quantitative Criminology*. 2014;30(4):629-650. http://search.ebscohost.com/login.aspx?direct=true&db=sih&AN=99777686&site=eds-live. doi: 10.1007/s10940-014-9217-6.

46. Zimmerman G, M., Messner S, F. Individual, family background, and contextual explanations of racial and ethnic disparities in youths' exposure to violence. *Am J Public Health*. 2013;103(3):435-442. http://search.ebscohost.com/login.aspx?direct=true&db=c8h&AN=2011926808&site=eds-live. doi: 10.2105/AJPH.2012.300931.

47. Ulmer JT, Harris CT, Steffensmeier D. Racial and ethnic disparities in structural disadvantage and crime: White, black, and hispanic comparisons*. *Social Science Quarterly (Wiley-Blackwell)*. 2012;93(3):799-819. http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=78323166&site=eds-live. doi: 10.1111/j.1540-6237.2012.00868.x.

48. Parham-Payne W. The role of the media in the disparate response to gun violence in america. *J Black Stud*. 2014;45(8):752-768. http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=99406146&site=eds-live. doi: 10.1177/0021934714555185.

49. Johnson SB, Bradshaw CP, Wright JL, Haynie DL, Simons-Morton B, Cheng TL. Characterizing the teachable moment: Is an emergency department visit a teachable moment for intervention among assault-injured youth and their parents? *Pediatr Emerg Care*. 2007;23(8):553-559. http://search.ebscohost.com/login.aspx?direct=true&db=c8h&AN=2009660788&site=eds-live.

50. Notarianni MA, Clements PT, Tillman HJ. Caring for the future: Strategies for promoting violence prevention in pediatric primary care. *J Am Acad Nurse Pract*. 2007;19(6):306-314. http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=25150161&site=eds-live. doi: 10.1111/j.1745-7599.2007.00230.x.

51. Cunningham R, Knox L, Fein J, et al. Before and after the trauma bay: The prevention of violent injury among youth. *Ann Emerg Med*. 2009;53(4):490-500. http://search.ebscohost.com/login.aspx?direct=true&db=c8h&AN=2010254811&site=eds-live. doi: 10.1016/j.annemergmed.2008.11.014.

52. Cheng TL, Haynie D, Brenner R, Wright JL, Chung S, Simons-Morton B. Effectiveness of a mentor-implemented, violence prevention intervention for assault-injured youths presenting to the emergency department: Results of a randomized trial. *Pediatrics*. 2008;122(5):938-946 9p. http://search.ebscohost.com/login.aspx?direct=true&db=c8h&AN=105584727&site=eds-live.

53. Cooper C, Eslinger DM, Stolley PD. Hospital-based violence intervention programs work. *J Trauma*. 2006;61(3):534-540. http://search.ebscohost.com/login.aspx?direct=true&db=c8h&AN=2009289483&site=eds-live.

54. Snider CE, Nathens AB. Where should we implement emergency department secondary prevention programs for youth injured by violence? *JOURNAL OF TRAUMA*-

INJURY INFECTION AND CRITICAL CARE. 2010;69(4):991-994. http://search.ebscohost.com/login.aspx?direct=true&db=edswsc&AN=000282959100064&site=eds-live.

55. National network of hospital-based violence intervention programs. nnhvip.org. Accessed October/ 4, 2015.

56. Champion VL, Skinner CS. The health belief model. In: Glanz K, Rimer BK, Viswanath K, eds. *Health behavior and health education: Theory, research, and practice*. 4th Edition ed. San Francisco, CA, US: Jossey-Bass; 2008:45-65. http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=1990-98174-002&site=eds-live.

57. Butkus R, Weissman A. Internists' attitudes toward prevention of firearm injury. *Ann Intern Med*. 2014;160(12):821-827. http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=96555213&site=eds-live.

58. Graziano M, Pulcini J. Gun violence and the role of health care: A confusing state of affairs. *Am J Nurs*. 2013;113(9):23-25. http://search.ebscohost.com/login.aspx?direct=true&db=cmedm&AN=23985600&site=eds-live. doi: 10.1097/01.NAJ.0000434174.40289.af.

59. Knox LM, Lomonaco C, Elster A. Training physicians and nurses in youth violence prevention: American medical association's youth violence prevention training and

outreach guide. *Am J Prev Med*. 2005;29:226-229. http://search.ebscohost.com/login.aspx?direct=true&db=edselp&AN=S0749379705003259&site=eds-live. doi: 10.1016/j.amepre.2005.08.029.

60. Howard PK. Injury prevention: An overview of a few well-known national children's gun safety programs and ENA's newly developed program. *Journal of Emergency Nursing*. 2001;27:485-488. http://search.ebscohost.com/login.aspx?direct=true&db=edselp&AN=S0099176701865326&site=eds-live. doi: 10.1067/men.2001.118613.

61. Sege RD, Licenziato VG, Webb S. Training physicians and nurses in youth violence prevention: Bringing violence prevention into the clinic. the massachusetts medical society violence prevention project. *Am J Prev Med*. 2005;29:230-232. http://search.ebscohost.com/login.aspx?direct=true&db=edselp&AN=S0749379705003132&site=eds-live. doi: 10.1016/j.amepre.2005.08.017.

62. Runyan CW, Gunther-Mohr C, Orton S, Umble K, Martin SL, Coyne-Beasley T. Training public health professionals in youth violence prevention: Prevent. A program of the national training initiative on injury and violence prevention. *Am J Prev Med*. 2005;29:252-258. http://search.ebscohost.com/login.aspx?direct=true&db=edselp&AN=S0749379705003090&site=eds-live. doi: 10.1016/j.amepre.2005.08.013.

63. Santos RB. The effectiveness of crime analysis for crime reduction: Cure or diagnosis? *J Contemp Crim Justice*. 2014;30(2):147.

http://search.ebscohost.com/login.aspx?direct=true&db=edb&AN=95878986&site=eds-live.

64. Butts JA, Roman CG, Bostwick L, Porter JR. Cure violence: A public health model to reduce gun violence. *Annu Rev Public Health*. 2015. http://search.ebscohost.com/login.aspx?direct=true&db=cmedm&AN=25581151&site=eds-live.

65. Braga AA, Weisburd DL. The effects of focused deterrence strategies on crime: A systematic review and meta-analysis of the empirical evidence. *J Res Crime Delinquency*. 2012;49(3):323-358. http://search.ebscohost.com/login.aspx?direct=true&db=edswss&AN=000306665600001&site=eds-live.

66. Whitehill JM, Webster DW, Frattaroli S, Parker EM. Interrupting violence: How the CeaseFire program prevents imminent gun violence through conflict mediation. *J Urban Health*. 2014;91(1):84-95. http://search.ebscohost.com/login.aspx?direct=true&db=cmedm&AN=23440488&site=eds-live. doi: 10.1007/s11524-013-9796-9.

67. Rector K. Mayor says safe streets anti-violence program to be expanded, relocated under criminal justice office. *Baltimore Sun*. 2017;News/ Maryland/ Crime.

68. Huie S. The concept of neighborhood in health and mortality research. *SOCIOLOGICAL SPECTRUM*. 2001;21(3):341-358.

http://search.ebscohost.com/login.aspx?direct=true&db=edswss&AN=000169532900007&site=eds-live.

69. Krieger N, Waterman P, Chen JT, Soobader M, Subramanian SV, Carson R. Zip code caveat: Bias due to spatiotemporal mismatches between zip codes and US census-defined geographic areas--the public health disparities geocoding project. *Am J Public Health*. 2002;92(7):1100-1102. http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=20396119&site=eds-live.

70. Cook PJ, Rivera-Aguirre A, Cerdá M, Wintemute G. Constant lethality of gunshot injuries from firearm assault: United states, 2003-2012. *Am J Public Health*. 2017;107(8):1324-1328. http://survey.hshsl.umaryland.edu/?url=http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=124124611&site=eds-live. doi: 10.2105/AJPH.2017.303837.