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*Western Journal of Emergency Medicine:*  
 Integrating Emergency Care with Population Health  
 Indexed in MEDLINE

**Special Issue on Firearm Violence  
 Injury and Prevention**



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# Firearms Injury Prevention, Emergency Medicine, and the Public's Health: A Call for Unity of Purpose

Chadd K. Kraus, DO, DrPH\*  
Mark I. Langdorf, MD, MHPE†

\*Geisinger, Department of Emergency Medicine, Danville, Pennsylvania  
†University of California, Irvine, Department of Emergency Medicine, Irvine, California

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We enthusiastically present the *Western Journal of Emergency Medicine (WestJEM)* Special Issue on Firearms Injury Prevention. This project is the culmination of several years of discussions, deliberations, and evaluations of peer-reviewed manuscripts.

Critics might call an issue of *WestJEM* focused on firearms-related injury and death as politically motivated or skewed. This issue of *WestJEM* is not intended to litigate gun laws or regulations. It is not meant to further divide strongly held views on the topic with blanket proposals for or against legislative or regulatory approaches. While necessary, the spirited discussions of legislative and regulatory measures are beyond the scope of this special issue. On the contrary, we offer a collection of peer-reviewed research, editorials, and perspectives to engage emergency physicians in productive discussions toward practical solutions to reduce firearms-related morbidity and mortality. Papers in this issue provide regional and national perspectives on firearms-related injuries, thought-provoking perspectives on firearms, descriptions of injury patterns and characteristics, and injury prevention and risk reduction strategies such as safe storage. As the editors of this special issue, we hope these papers will move the discussion forward with evidence and expert consensus.

We appreciate that violence and injuries with firearms are one of many public health challenges for emergency physicians, and all of these (e.g., motor vehicle safety, interpersonal violence) merit scientific inquiry, evaluation, and discussion. The response that “knives injure and kill, cars injure and kill, etc...” oversimplifies the morbidity and mortality from firearms and disregards the demonstrated effectiveness of injury prevention research in public health and emergency medicine. Firearms-related research has been a controversial, “hot potato” in the interplay of science and politics, particularly following the 1996 Dickey Amendment that effectively halted federally funded research on firearms if it involved gun control.<sup>1-3</sup> The more controversial the topic, the more we need to engage our objective, scientific inquiry, and the less we should rely on emotion. We hope that this issue will be thought-provoking and productive.

As in broader society, the mere mention of firearms is potentially divisive among emergency physicians, with approximately 40% of members of the American College of Emergency Physicians (ACEP) owning firearms.<sup>4</sup> The American Board of Emergency Medicine 2019 Model of the Clinical Practice of Emergency Medicine recognizes “firearm injury prevention” among the evolving trends in health care delivery that emergency physicians should know as part of the core content of emergency medicine.<sup>5</sup> Yet many emergency physicians are unfamiliar with the safe handling of firearms.<sup>6</sup> The ACEP Policy on Firearm Safety and Injury Prevention “condemns the current rates of injury and death from firearms in the United States.”<sup>7</sup> More recently, California ACEP updated its 2013 firearm injury prevention policy to reaffirm strategies such as child-protective safety and storage and extreme risk protection orders to reduce injury and death related to firearms.<sup>8</sup> Unlike the broader society, as emergency physicians we have unique, first-hand experience with firearm-associated injuries and deaths. Our specialty is harmed by firearms-related violence, whether in the trauma bay or when it claims the lives of fellow emergency physicians like Drs. Tamara O’Neal and Kevin Rodgers.<sup>9,10</sup> As emergency physicians, we can, and we must, be the example of civil, respectful, and evidence-based approaches to finding solutions to the most challenging public health problems. There is room for disagreement about firearms; more importantly, there is opportunity and responsibility for us to use our professional experiences, expertise, and perspectives to lead objective, respectful, civil, and evidence-based discussions about how to reduce disability and death from all causes, including firearms. These discussions, while uncomfortable, are squarely “in our lane.” If not us, then whom?

In full disclosure, as editors of this special issue, we are disparate with regard to firearms. One owns firearms, one does not. One lives where gun ownership is uncommon, one where ownership is common. In the context of this diversity, we share unity of purpose, and invite our emergency physician colleagues, public health and other researchers, and the broader public, to engage in civil discourse and research.

**Address for Correspondence:** Chadd Kraus, DO, DrPH, Geisinger Medical Center, Department of Emergency Medicine, 100 North Academy Avenue, Danville, PA 17822. Email: chaddkraus@gmail.com.

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# The Utstein Kloster and Its Role in Firearm Violence Policy

Galen Adams, MD

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The Utstein *Kloster*<sup>1</sup> (Norwegian for abbey) is Norway's best-preserved medieval monastery. Utstein Abbey was consecrated in the late 13<sup>th</sup> century and still functions today as a church and convent. The abbey (Figure 1) has also been the host site of several landmark analyses pertinent to emergency medicine, most notably on drowning,<sup>2</sup> cardiac arrest,<sup>3</sup> and trauma<sup>4</sup> resuscitation. The Utstein style of analysis has been successfully developed as a multidisciplinary research framework for disaster medicine analysis.<sup>5</sup> The Utstein style intentionally combines experts with a variety of scientific expertise in fields related to complex, multidimensional problems. Rather than a focus on narrow legal, policy, organizational, or sociological aspects of a disaster, the Utstein style borrows its multifactorial approach from Newtonian physics. The Utstein style analytical framework may be adapted to any multidimensional complex hazard such as firearm violence.

In Utstein style analysis, any potential disaster may be characterized as a *hazard* with stored potential energy. The *risk* of conversion of that potential energy to an *event* with kinetic energy occurs either at a statistically estimable rate (eg, hurricanes), or due to stochastic triggers (eg, terrorism). The *risk* of an *event* becoming manifest can be modified through surveillance and prevention strategies, designed for each *hazard*. Should an *event*

occur, the kinetic energy expended upon a population is termed *impact*. In the case of modern firearms, both the kinetic energy and the resulting *impact* are highly lethal.<sup>6</sup> The *vulnerability* of the population to the *impact* determines the *damage* to that population. After *impact* occurs, *damage* to the *vulnerable* population may be only be modified by timely active response and resources termed *resilience*. In the best case, the *prevention* of a *hazard* removes or disables its potential energy, rendering it harmless. If an *event* is allowed to *impact* a *vulnerable* population, the *damage* is mitigated by the *resilience* of the community. The Utstein style is an analytical heuristic, similar to the Haddon matrix,<sup>7</sup> employed to separate and analyze the contribution of individual factors in the control of injury.

With respect to firearm violence, the citizen misuse of firearms would be the *hazard* in the Utstein framework. Along with Mexico and Guatemala, the United States (US) is one of three nations on earth that designates firearm possession as a Constitutional right and not a privilege. Therefore, the *hazard* of firearm violence cannot be *prevented* without amending the US Constitution. For this reason, our collective challenge is to find a better way to modify the *risk* of civilian misuse of firearms. State and local firearm ordinances represent an attempt at *risk* modification through a patchwork of restrictive and permissive strategies in which uniform enforcement is not possible. A wide variety of socioeconomic and cultural communities are overlaid on that patchwork of laws making the application of “gun control laws” confusing and contradictory. One law does not work in all places.

There are states, and in fact nations, that have high firearm ownership (ie, elevated *hazard*) and low rate of firearm violence (ie, low *event* occurrence), such as Hawaii, Idaho, Montana, Wyoming, or Switzerland. In contradiction, there are cities with both a high level of firearm regulation (ie, elevated *risk* mitigation) and a paradoxically high level of firearm violence (ie, elevated *event* rate) such as the District of Columbia or Chicago. The risk of firearm violence in the US resembles an archipelago of high-*risk* firearm violence islands with interspersed large zones of minimal *risk* oceans. One strategy does not fit all locations.



**Figure 1.** Anonymous 18th-19th century painting of Utstein Abbey (photographer Froda Inga Helland).

One possible explanation for these conflicting examples is perhaps that the problem is less about the firearm (ie, *hazard*) and more about the factors involved in motivating a citizen to misuse firearms. Because Second Amendment arguments lend themselves to primal emotions on both sides, too much energy is expended on the right of firearm possession vs dispossession (ie, *prevention*) and not enough on identifying and intervening in the factors leading up to the shooting or *risk* modification.

Americans accept the *risk* modification over *prevention* approach with motor vehicle accidents, swimming pool drownings, and air travel. Good policy and the avoidance of polarizing anger is guided by collecting data and using that data to analyze and modify *risk*. For example, the Haddon matrix has been used to modify the *risk* associated with motor vehicle travel. By separately analyzing pre-crash, crash, and post-crash factors, data-driven vehicle and highway designs are combined with regulatory, sociological, and psychological solutions to reduce motor vehicle injuries. Very few Americans are prohibited from driving a vehicle and the *risk* from motor vehicles crashes are mitigated by data-driven solutions.

With the acknowledgment that accidental firearm injury (eg, hunting accidents) is not included in this analysis, the issue of intentional firearm violence has at least four key categories:

- Suicide or self-harm
- Intimate partner, family, or business partner violence
- Criminal activity
- Mass shootings and assassinations

In each category, there are different factors that determine the *risk* of firearm violence becoming an *event*. Further, the target population has different *vulnerabilities*, with many different mitigation strategies. Like motor vehicle speed limits, one strategy does not fit all problem sets.

Suicide by firearm represents over one third of total firearm deaths in the US,<sup>8</sup> and there are clear demographic groups (older White males), and predisposing circumstances (financial loss, family loss, loss of community stature) that correlate well with suicidality. These are stochastic triggers that indicate an individual's likelihood of a firearm-assisted suicide and they are surveillable. A reporting system with data-driven intervention strategies such as peer outreach, psychological resources, or short-term firearm dispossession for identified high-risk individuals, may reduce the *risk* of a firearm-assisted suicide event in this category.

Intimate partner violence, family conflict, or revenge on business associates are significant subcategories for children and adults. Each of these subcategories involves some level of conflict or rejection, combined with a malign adjustment reaction. Similar to child abuse, or domestic abuse not involving firearms, there are higher risk individuals and precipitating events (eg, divorce, infidelity, family rejection, bankruptcy, larceny, etc) that are surveillable. Individuals undergoing these precipitating events may be screened and have data-driven resources provided such as personal, legal, and/or financial

counselling. Higher *risk* individuals may be evaluated for short-term firearm dispossession and crisis counseling.

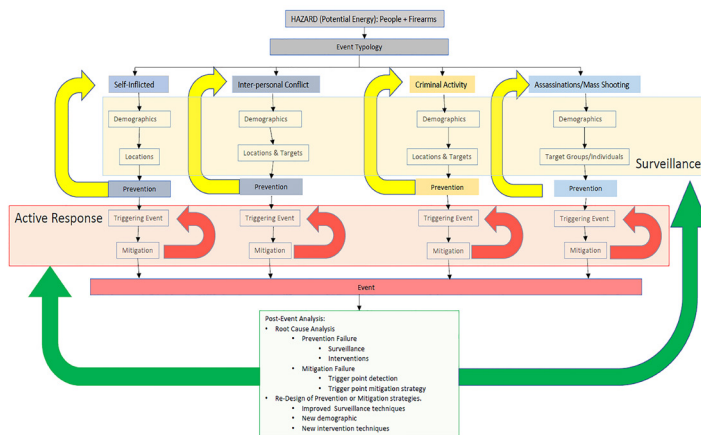
Given the cost of the judicial and prison systems in the US, criminal activity with firearm violence has perhaps the largest total resource allocation of the subsets. Great efforts have been made to predict criminal activity by better understanding the spatial, temporal, and perpetrator-victim associations of specific crimes. The risk modification of criminal behavior has received much less attention. If we assume that all people are born with more or less the same inclination to crime, then poor schools, gang activity, and systemic racial bias that produce disparate justice system outcomes are specific risk factors associated with poor and minority communities. These structural factors contribute to a loss of legitimate academic and/or economic opportunities and are a driver of criminal behavior. Consider, the US has 5% of the world's population yet 25% of the world's incarcerated population. Blacks and Hispanics represent 32% of the US population but 56% of the incarcerated population. While Blacks comprise 13% of the US population, 35% of those executed in the past 40 years are Black. Approximately half of those incarcerated will return to prison and 75% of formerly incarcerated people are unemployed.<sup>9</sup> Simply stated, the imprisonment of poor and minority populations is not the answer to firearm violence. There is no doubt that the solution to systemic racial bias and its associated criminality is complex and will be difficult to overcome in the short term. That stated, to not address systemic racial bias will increase the *risk* of segments of our population to criminal behavior and associated firearm violence at a great cost in both lives and dollars.

While the category of mass shootings and assassinations is the most newsworthy and consistently evokes public outcry, it is actually 1-2% of the total firearm violence.<sup>10</sup> Similar to criminal activity, great efforts have been made to mitigate mass shootings and assassinations, mainly through various dignitary protection strategies and the improvement of security for vulnerable sites (eg, schools, airports, public buildings). Like police funding for criminal activity, the mitigation of mass shootings and assassinations receives a large amount of the funding. Mass shooters and assassins do have distinct psychological profiles that occasionally include some elements of mental illness, being bullied, grievance, and perhaps the need for notoriety/revenge. Mass shooters are predominantly male and White and are often driven by a malign cause. Once again, these stochastic triggers are surveillable. Once identified, targeted resources directed to these vulnerable individuals with peer counseling, alternatives to violence, and firearm dispossession for recalcitrant individuals may decrease the incidence of these events.

For too long the US has avoided an injury control perspective, largely due to the Dickey Amendment of 1996,<sup>11</sup> which prohibited the Centers for Disease Control and Prevention to collect these data. With the repeal of the Dickey Amendment in 2018, a new era of firearm injury control research is now possible. By adopting an injury control model such as the Utstein

style analysis or the Haddon matrix, the factors associated with different categories of firearm violence may be identified and analyzed, and data-driven interventions developed and deployed. To remain in the status quo ensures that the US will remain a world leader in preventable firearm deaths. The door to a better way to control firearm injury has been opened. We have the ability to replace the overheated arguments on gun control with data-driven solutions for firearm violence.

A notional system to modify the issue of firearm violence is depicted in Figure 2. This Utstein style framework would require societal investment to identify and intervene in the risk factors of firearm violence. With data comes clarity and rational policies, tailored to each subset of problems and the locations and populations at risk. Informed with data, gun violence policy may improve, and firearm injuries may be reduced.



**Figure 2.** A notional Utstein framework to reduce firearm violence.

**Address for Correspondence:** Galen Adams, MD. Email: galen.adams.md01@gmail.com.

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# Nonfatal Firearm Injuries by Intent in the United States: 2016-2018 Hospital Discharge Records from the Healthcare Cost and Utilization Project

Kathryn Schnippel, PhD\*  
Sarah Burd-Sharps, MIA\*  
Ted R. Miller, PhD†  
Bruce A. Lawrence, PhD†  
David I. Swedler, PhD†

\*Everytown for Gun Safety Support Fund, New York, New York  
†Pacific Institute for Research and Evaluation, Calverton, Maryland

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**Introduction:** In addition to the nearly 40,000 firearm deaths each year, nonfatal firearm injuries represent a significant public health burden to communities in the United States. We aimed to describe the incidence and rates of nonfatal firearm injuries.

**Methods:** We calculated nonfatal firearm injury estimates using the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality, including the Nationwide Emergency Department Samples and the National Inpatient Samples. We used the International Classification of Diseases, 10th Revision, Clinical Modification to identify firearm injury episodes. Deaths in the emergency department (ED) or as inpatients were excluded.

**Results:** In addition to the 118,171 persons shot and killed by firearms from 2016–2018, 228,380 people were shot (ratio 1.9:1) and treated at a hospital ED or admitted to hospital, a rate of 23.4 nonfatal firearm injury episodes per 100,000 population. The number of nonfatal injury episodes varied by year: 2018 had the lowest at 69,692, compared to 84,776 in 2017 and 73,912 in 2016. Unintentional injury episodes were the most frequent, accounting for 58.5% (n = 81,217) and 38.9% (n = 34,820) of total nonfatal firearm hospital discharges from the ED and inpatients, respectively. Assault episodes were the next most frequent, at 36.3% (n = 50,482) of ED and 49.5% (n = 44,290) of inpatient discharges. The highest rate of nonfatal firearm injury by five-year age group was for 20- to 24-year-olds. With an annual rate of 73.53 per 100,000 population, the rates for ages 20-24 were more than 10 times higher than the rates for patients younger than 15 or 60 years and older. More than half (53.4%, n = 121,884) of hospital-treated, nonfatal firearm injury episodes were patients living in ZIP codes with a median household income in the lowest quartile, compared to 7.5% (n = 17,102) for patients residing in the highest income quartile ZIP codes, a sevenfold difference.

**Conclusion:** For every person shot and killed by a gun in the US, two more are wounded. Unlike firearm deaths, which are predominantly suicides, most nonfatal firearm injury episodes are unintentional or with an assault intent. Having a reliable source of nonfatal injury data is essential to understanding the incidence of firearm injuries. [West J Emerg Med. 2021;22(4.1):6–14.]

## INTRODUCTION

The story of gun violence in the United States is often told through the deaths that are reported through the National

Vital Statistics System by the US Centers for Disease Control and Prevention (CDC): more than 100 gun deaths each day.<sup>1</sup> But an often-overlooked part of today's gun violence crisis

are nonfatal injuries. Understanding the contours of these injuries—where, to whom, and how often—is essential for developing solutions. Knowing more about nonfatal gun injuries is essential information to enable doctors, emergency medical technicians, police departments, policymakers, and trauma hospitals to plan for future need. It is also important for studying the survival rate of those wounded by a gunshot and could provide important signals for understanding trends in the criminal use of firearms. In an effort to fill this critical gap, we analyzed hospital administrative data from the Healthcare Cost and Utilization Project (HCUP) for 2016–2018, the most recent years available at the time the research was undertaken, using data on emergency department (ED) and inpatient hospital discharges for nonfatal firearm injuries.

## METHODS

Nonfatal firearm injury incidence estimates are calculated from HCUP databases. Coordinated by the Agency for Healthcare Research and Quality, HCUP databases bring together the data collection efforts of state data organizations, hospital associations, and private data organizations, the HCUP Data Partners. The Partners are listed on the HCUP-US website at <https://www.hcup-us.ahrq.gov/db/hcupdatapartners.jsp>. Emergency department discharges are from the Nationwide Emergency Department Samples (NEDS) for 2016–2018.<sup>2</sup> Inpatient (admitted) discharges are from the corresponding National Inpatient Sample (NIS).<sup>3</sup> We applied discharge-level weights to the survey sample in NEDS and NIS to calculate representative estimates for the US.

Unweighted, a single year of NEDS includes approximately 33.5 million hospital discharges that started in the ED; the weighted sample sums to 145 million ED discharges. For 2018, NEDS approximated a 20% stratified sample of hospital-owned EDs in the US and included data from 990 hospitals across 36 partnering states and the District of Columbia.<sup>2</sup> Unweighted, a single year of NIS includes approximately seven million inpatient hospital admissions to community hospitals, excluding rehabilitation and long-term acute care hospitals; the weighted sample provides estimates for more than 35 million admissions. For 2018, NIS approximated a 20% random sample of discharges from each hospital in the 47 partnering states and the District of Columbia.<sup>3</sup>

To avoid double-counting across the two datasets, we dropped inpatient admissions to the same hospital and transfers to other inpatient facilities from the NEDS dataset as it was assumed the hospital admission would be represented by the NIS dataset. To avoid double-counting fatal injuries reported by the CDC, we excluded firearm-related hospital discharges that resulted in death in the ED or as an inpatient. Additionally, as NEDS and NIS are both cross-sectional snapshots, we did not count subsequent encounters or sequelae.

## Analysis

We extracted hospital discharge records for patients with firearm-related injuries using the National Center for Health

### *Population Health Research Capsule*

What do we already know about this issue?  
*Fatal and nonfatal firearm injuries represent a significant public health burden to the US; however, there is little data on nonfatal injuries.*

What was the research question?  
*We examined hospital discharges to understand which patients and communities are most impacted by nonfatal gun injuries.*

What was the major finding of the study?  
*For each firearm death, there are two injuries; nearly all firearm injuries are unintentional or with an assault intent.*

How does this improve population health?  
*Prevention efforts must address the disproportionate burden of nonfatal firearm injuries on racial minorities and low-income and urban communities.*

Statistics' *International Classification of Diseases, 10<sup>th</sup> Revision, Clinical Modification* (ICD-10) codes<sup>4</sup> for initial encounters related to firearm discharges. We excluded injuries as a result of firearm malfunction or injuries of any intent from gas, air, or spring-operated guns, paintball guns, and rubber bullets. For the 2016 dataset, ICD-10 codes related to injuries were captured under a specific variable for external cause of morbidity. Beginning with the 2017 dataset, ICD-10 codes for external causes are included in the diagnosis codes<sup>2,3</sup>; firearm injuries were extracted from all possible diagnoses (e.g., up to 35 unique codes in NEDS), regardless of other diagnoses reported.

Hospital discharges were assumed to represent an injury episode. One person may have sustained multiple gunshot wounds in the same firearm injury episode and would be counted once for the hospital discharge. It is also possible that one person may have multiple firearm injury episodes in a year and, therefore, the incidence of firearm injury episodes may be higher than the number of unique persons experiencing a firearm injury episode in the year.

The ICD-10 codes are categorized according to injury intent: assault (including assault by terrorism); self-harm (including attempted suicide); legal intervention (shootings by police); injuries considered unintentional; and injuries where the intent was undetermined. The larger ICD-10 external injury category for legal intervention includes operations of war and military operations; however, the counts reported here are only for legal intervention involving firearm discharge where the law enforcement officer, bystander, or suspect

was injured. A full list of included codes is available in the supplemental appendix.

The ICD-10 codes Y90-Y99 are available for supplementary factors related to external injuries. Evidence of alcohol involvement, place of occurrence (e.g., residence, school, business, public space), and activity at time of injury were explored. However, as most firearm injuries had no supplementary factor codes or no information provided in these codes (e.g., coded as unspecified or not applicable), we did not report these supplementary factors.

We provide descriptive statistics using variables as available and coded in the datasets. Injuries were described using injury intent and whether the patient was discharged from the ED or after inpatient admission. For inpatients, the NIS files also include information on the “All Patients Refined Diagnosis Related Groups” (APR DRG) subclassifications for the risk of mortality (minor, moderate, major or extreme likelihood of dying) and the severity of illness (minor, moderate, major, or extreme loss of function).<sup>3</sup> Patient individual characteristics were described for gender (male or female) and age from both NEDS and NIS. Combined race and ethnicity (categorized as Asian or Pacific Islander, Black, Hispanic, Native American, White, and other races including mixed race) was available for inpatients only.

Both datasets included the urban-rural classification of the county of patient residence, categorized as the following: large central metro (counties with significant population of a metropolitan statistical area of one million or more); large fringe metro (counties in a metropolitan statistical area but not considered central); medium metro (counties in a metropolitan statistical area of 250,000 to 999,999 population); small metro (counties in a metropolitan statistical area of less than 250,000 population); and micropolitan or noncore (rural).<sup>5</sup> Both datasets also included the median household income quartile of the patient ZIP code as categorized in the dataset; the quartiles were defined for each year, with the lowest quartile including ZIP codes with a median income of up to \$42,999 in 2016 and \$45,999 in 2018. Hospital characteristics common to both datasets were limited to the US Census region (Midwest, Northeast, South, and West).

We calculated annual crude population rates per 100,000 population on the weighted national estimates using the population file from HCUP released in 2020 for the three years 2016–2018.<sup>6</sup> All analysis was done in Stata, release 16 (StataCorp., College Station, TX) using the survey commands to account for the weighting.

The HCUP datasets are public use files that do not include any patient-level identifying information; therefore, this was not considered human subject research. Counts less than 10 are suppressed as per restrictions on the dataset. The study is presented in accordance with STROBE reporting guidelines for cross-sectional observational studies.<sup>7</sup>

**RESULTS**

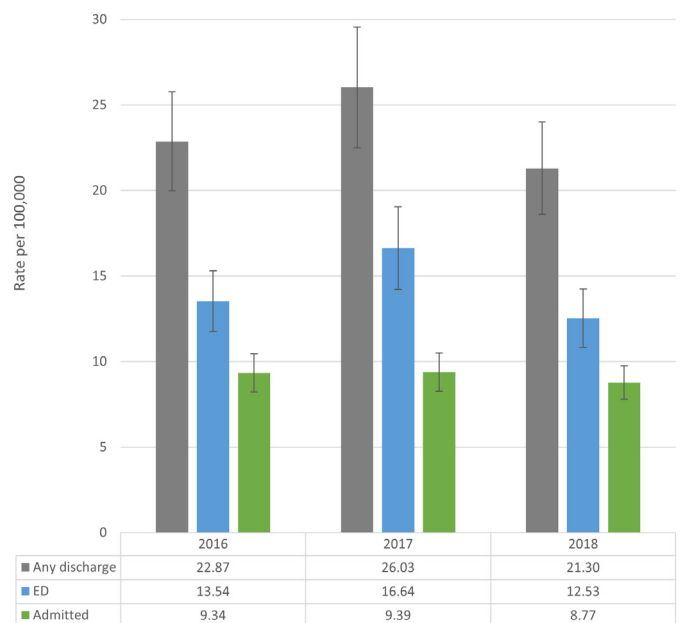
From 2016–2018, hospitals provided an estimated 228,380 episodes of care (95% confidence interval [CI], 213,824 to

242,936) for nonfatal shootings in the United States, a rate of 23.40 per 100,000 population (95% CI, 21.91 to 24.89). Excluding follow-up visits, national estimates include 138,935 (60.8%) nonfatal firearm injury episodes treated only in the ED (95% CI, 125,737 to 152,133) and 89,445 (39.2%) treated as inpatients (95% CI, 83,386 to 95,504).

From the NEDS alone across the three years, there were 63,150 initial encounter episodes where firearm was the mechanism of injury (a weighted national estimate of 264,886) in total for all injury intents. To avoid double-counting NIS admissions, we excluded 26,197 (41.5% of firearm-coded injuries) NEDS discharges to an inpatient admission to the same hospital or transferred as inpatient (weighted estimate of 109,432). Additionally, we excluded from the analyses 3840 patients who died in the ED (10.4%, weighted estimate n = 16,419) and 1,651 patients who died in hospital (8.5%, weighted estimate n = 8,255). The combined weighted estimate of 24,674 deaths excluded represent 85% of the CDC-reported 29,009 firearm injury deaths in medical facilities as inpatient, outpatient or ED, and dead on arrival.

**Injury Characteristics**

There is no clear trend in the rate of nonfatal firearm injury episodes (Figure 1) over these three years, and confidence intervals overlap. The number of nonfatal firearm injury



**Figure 1.** Rate of nonfatal firearm injury episodes in the United States per 100,000 population, by year, 2016-2018. Admitted nonfatal firearm injury episodes from the National Inpatient Sample (2016-18). Emergency department (ED) nonfatal firearm injury episodes from the Nationwide Emergency Department Sample (2016-18). Population from Healthcare Cost and Utilization Project files. Lines represent 95% confidence intervals for weighted survey estimates.

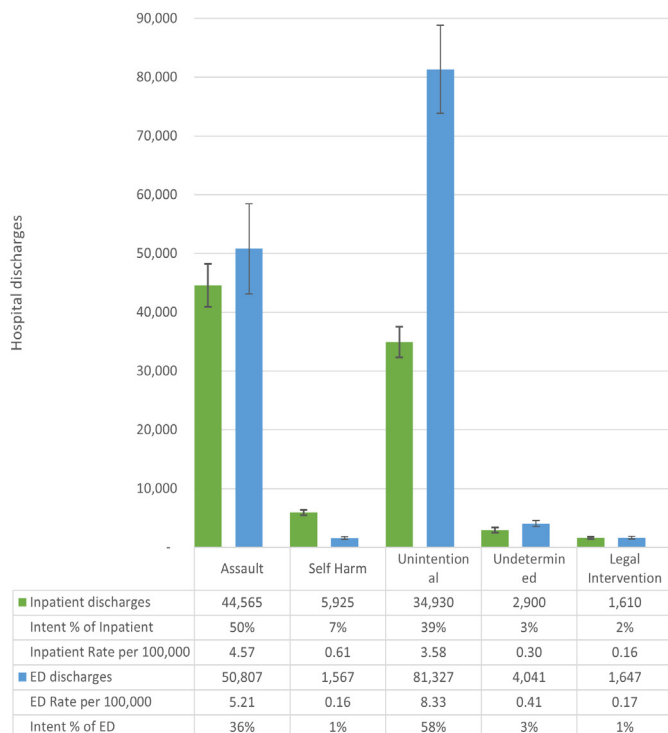
episodes varied by year: 2018 had the lowest incidence of 69,692, compared to 84,776 in 2017 and 73,912 in 2016. The difference was driven by ED episodes in NEDS. The 2018 incidence of 40,992 episodes was 24.4% lower than the 54,206 in 2017. For inpatient episodes, the NIS national estimate of 28,700 episodes was 6.1% lower in 2018 compared to 2017 (n = 30,570). On average, there were 76,127 nonfatal firearm injury episodes per year, including 46,312 discharged from the ED and 29,815 treated as inpatients.

Across both ED and inpatient episodes, firearm type was usually categorized as other or unspecified (68.9%, n = 157,316). Among the injuries with firearm type categorized, across all intents, injuries were most frequently attributed to handguns (80.2%) compared to long guns (e.g., rifles or shotguns, 19.8%). Overall, unintentional injury episodes were the most frequent, accounting for 58.5% (n = 81,217) and 38.9% (n = 34,820) of total nonfatal firearm hospital episodes from the ED and inpatients, respectively (Figure 2). Assault episodes were the most frequent among inpatient discharges (49.5%, n = 44,290) and second highest for ED discharges (36.3%, n = 50,482). The other three intents combined –

intentional self-harm, undetermined and legal intervention – made up 5.2% (n = 7,236) and 11.6% (n = 10,335) of ED and inpatient episodes, respectively.

The NIS dataset also includes variables about the risk of mortality and severity of the injury using the APR DRG subclassifications for risk of mortality and severity of illness as detailed in Table 1. Among survivors of hospital-admitted injury, 12.2% (n = 10,900) had been categorized as being at extreme risk of dying based on the firearm injuries sustained. A higher number of patients, 18,770 (21.0% of the nonfatal firearm inpatient discharges) experienced an injury severe enough to be categorized as causing extreme loss of function. Specific to intent, nonfatal self-harm injury patients had the highest frequency of being classified as extreme risk of dying (20.6%, n = 1,220) or causing an extreme loss of function (29.6%, n = 1,755), and unintentional injury patients had the lowest relative frequency for both severity classifications (10.3%, n = 3,895 and 17.1%, n = 6,475).

The mean length of inpatient hospital stay was 7.95 days (95% CI, 7.73 to 8.16). Routine discharge from inpatient admission was the most frequent outcome (74.2%, n = 66,370 patients). However, 12.4% (n = 11,060) were discharged to an “other” facility such as skilled nursing or intermediate care, and 8.5% (n = 7,625) were discharged to home health care.



**Figure 2.** Number, rate per 100,000 population, and proportion of admitted and emergency department (ED) discharges for nonfatal firearm injuries in the United States, by injury intent, 2016-2018. Admitted firearm injury episodes estimated from the National Inpatient Sample (2016-18). Emergency department discharges estimated from the Nationwide Emergency Department Sample (2016-18). Lines represent 95% confidence intervals for weighted survey estimates. Proportions are for rows and may not total to 100% because of rounding.

### Patient Characteristics

Most (87.3%, n = 199,320) nonfatal firearm injury episodes from 2016–2018 were among men and boys, a rate of 41.47 episodes per 100,000 population (95% CI, 38.83 to 44.12) (Figure 3). Two-thirds of patients (67.0%, n = 153,115) seen in hospital for firearm injuries were between the ages of 15-34 years. By far, the highest rate by five-year age group was for 20- to 24-year-olds with a rate of 73.53 per 100,000 population (95% CI, 67.86 to 79.20), more than 10 times higher than the rates for patients younger than 15 or 60 years and older. Nearly 1 in 10 (9.2%, n = 20,921) nonfatal firearm injury hospital episodes were pediatric patients under 18 years old (95% CI, 19,451 to 22,392).

Combined patient race and ethnicity were only available for the inpatient data (Figure 4). Black people, with 50.1% of the nonfatal firearm injury episodes requiring inpatient admission (n = 44,835) and a rate of 36.82 inpatient episodes per 100,000 people (95% CI, 33.22 to 40.41), have the highest rate, more than nine times higher than white people (3.95 per 100,000, 95% CI, 3.71 to 4.19).

### Community and Hospital Characteristics

Across all intents, rates of nonfatal firearm injury episodes were similar with overlapping confidence intervals in counties categorized as small metros, micropolitan, and noncore rural communities, on average 21.84 per 100,000 (Table 2). However, rates were approximately twice as high in counties with large central metro areas at 31.48 per 100,000 (95% CI, 27.93 to 35.03) compared to the suburban surrounding

**Table 1.** Number, row proportion, and rate per 100,000 population by injury characteristics for inpatient nonfatal firearm injury episodes for the United States, 2016-2018, based on inpatient hospital discharges from the National Inpatient Sample.

Category	Description	Total	Row proportion	Crude rate per 100,000
Total inpatient	Inpatient admission	89,445	36.1%	9.16
APR DRG risk of mortality	Minor likelihood of dying	50,655	56.6%	5.19
	Moderate likelihood of dying	14,110	15.8%	1.45
	Major likelihood of dying	13,755	15.4%	1.41
	Extreme likelihood of dying	10,900	12.2%	1.12
APR DRG severity of injury	Minor loss of function	17,170	19.2%	1.76
	Moderate loss of function	30,540	34.1%	3.13
	Major loss of function	22,940	25.6%	2.35
	Extreme loss of function	18,770	21.0%	1.92
Disposition of patient	Routine	66,370	74.2%	6.80
	Transfer to short-term hospital	2,295	2.6%	0.24
	Transfer other, includes skilled nursing	11,060	12.4%	1.13
	Home health care	7,625	8.5%	0.78
	Against medical advice	1,875	2.1%	0.19

APR DRG, All Patients Refined Diagnosis Related Groups.

counties (large fringe metros, 14.40 per 100,000). Patients living in ZIP codes with a median household income in the lowest quartile (ranging from less than \$43,000 per year in 2016 to less than \$46,000 per year in 2018) accounted for 53.4% (n = 121,884, 95% CI, 111,629 to 132,138) of all nonfatal firearm injury episodes compared to 7.5% (n = 17,102, 95% CI, 15,728 to 18,475) for patients residing in ZIP codes with median household incomes at the highest income quartile (at \$71,000 to \$79,000 and above), a sevenfold difference.

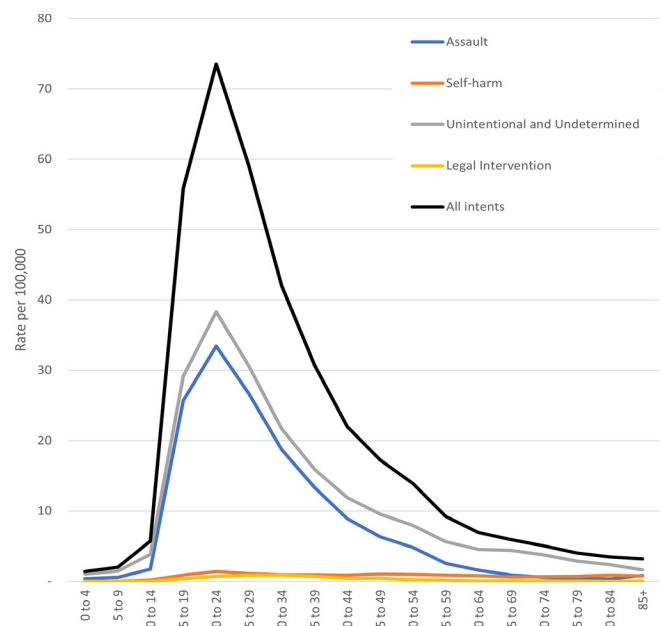
There were also considerable differences among the four US Census regions (Northeast, Midwest, South, and West). Half (50.0%, n = 114,224) of nonfatal firearm injury episodes occurred in the 16 states of the American South, with a rate of 30.81 per 100,000 (95% CI, 27.97 to 33.65), approximately twice that of the Northeast and of the West (13.22 and 16.85 per 100,000, respectively).

**DISCUSSION**

In addition to the 118,171 persons shot and killed by firearms from 2016–2018,<sup>1</sup> an estimated 228,380 people survived their injuries. Compared to firearm deaths, nearly two times as many people were shot and treated at a hospital ED and/or admitted to hospital, a rate of 23.40 nonfatal firearm injury episodes per 100,000 population. The socioeconomic and demographic makeup of those injured by firearms each year, with an average of 208 people per day who are wounded with a firearm and survive, tells an important story for focusing prevention efforts. As is evident from this analysis, the overall distribution of gun injuries by both demographic group and income is extremely uneven.

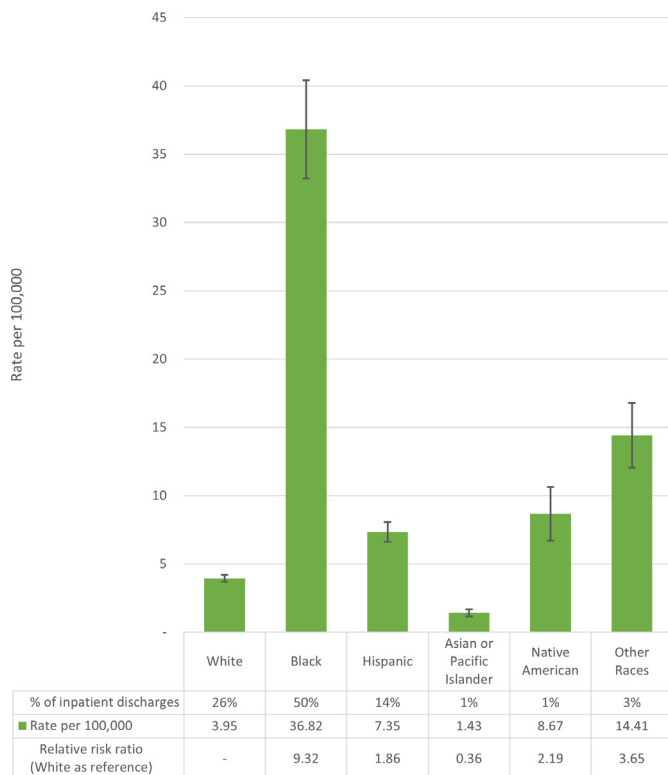
Eighty seven percent of those who visit a hospital for a

gunshot wound are male. The age group most impacted by nonfatal firearm injuries is young adults 20–24 years old, with a rate that is over 10 times higher than both youth (under 15)



**Figure 3.** Rate of nonfatal firearm injury episodes in the United States per 100,000 population, by 5-year age group and Injury Intent, 2016-2018.

Inpatient hospital discharges from the National Inpatient Sample and emergency department discharges from the Nationwide Emergency Department Sample. Population from Healthcare Cost and Utilization Project files.



**Figure 4.** Row proportion, rate per 100,000 population, and relative risk of nonfatal firearm injury episodes requiring inpatient admission for the United States, by combined race and Hispanic origin, 2016-2018, calculated from inpatient discharges in the National Inpatient Sample. Lines represent 95% confidence intervals for weighted survey estimates.

and older adults ( $\geq 60$ ). The rate of nonfatal firearm injury episodes requiring inpatient admission for Black people is over nine times higher than that of white people and the highest rate of the major US racial and ethnic groups. The Latino rate of nonfatal gun injuries is double that of non-Latino white people. These overlaps put Black young adult males at very high risk of nonfatal gunshot injuries. Through the lens of income, more than half of all nonfatal firearm injury episodes affect residents of communities in the poorest quartile for household incomes.

The distribution of those who are treated and survive also varies significantly by intent, with implications for prevention efforts that can reduce morbidity and mortality. The rate of those who are shot and survive in core central cities is triple the rate in rural areas and small towns. The burden of nonfatal firearm injury, particularly from assault and unintentional injuries, seems to be similar to firearm homicide in its disproportionate impact on Black adolescent boys and young men in urban communities.<sup>1</sup>

This analysis of the nonfatal firearm injury episodes from both ED and inpatient discharges provides a unique and more complete picture of the incidence of firearm injuries. Previous analyses of HCUP data often focused on either NEDS<sup>8,9</sup> or

NIS<sup>10,11</sup> but not both. A study of NEDS from 2006–2014 found the incidence of nonfatal ED visits (including those admitted as inpatients) to be 23.2 per 100,000, similar to the rate of 23.40 found here for 2016–2018.<sup>12</sup> A study of trends over time from the NEDS and NIS data was outside the scope of this descriptive analysis of the incidence of nonfatal firearm injury episodes. The three years included here had wide variation, particularly the 24% decrease from 2017 to 2018 in ED discharges for patients who survived and were not admitted as inpatients. A NIS-specific study found that the number of injuries was increasing over time from 1993–2014; further, the total of 24,445 inpatient admissions for firearm injuries in 2014 was lower than the average 29,815 estimated here for 2016–2018.<sup>10</sup> Our estimates, however, are 26% lower than the estimated 58,912 nonfatal admissions and 43,440 ED cases in 1992, similar to the decline in non-suicide firearm deaths over the same period (19,607 in 1992 and average of 15,649 for 2016–2018).<sup>13,14</sup>

The average annual incidence of 76,127 nonfatal firearm injuries for 2016–2018 is far lower than the 2016 estimate of 110,968 reported by the CDC in its Firearm Injury Surveillance Study.<sup>15</sup> The CDC has not reported nonfatal firearm injuries on its Web-based Injury Statistics Query and Reporting System website for 2016–2019 because the coefficient of variation exceeds 30% and the CDC has determined national weighted estimates are therefore unreliable.<sup>16</sup> The limitations of CDC firearm injury data stem in part from its small sample size of EDs. Currently, the agency's survey includes only about 66 hospitals—less than 2% of all hospitals in the US.<sup>15</sup> In comparison, hospitals included in the NIS cover 97% of the US population; therefore, the HCUP estimates are likely more accurate than CDC nonfatal injury reports.<sup>17</sup>

Of note, the NEDS dataset includes patients who were either admitted to the same hospital or discharged from the ED to another inpatient facility. The NIS sample of discharges from inpatient hospitals is both weighted to represent inpatient admissions and includes more states than the NEDS sample (weighted to represent hospitals with ED facilities) and therefore was assumed to be more accurate. While these NEDS inpatient estimates were excluded from this joint analysis of the NEDS and NIS, the differences in using estimates from only NEDS are important to consider. Across the three years, on average the NEDS estimate of inpatient admissions was 14.1% higher than the NIS estimate ( $n = 102,039$  vs  $n = 89,445$ ). However, most of this difference was in 2017. The 2017 estimate from NEDS of nonfatal firearm injuries requiring hospital admission was 35.6% higher than the NIS estimate for 2017 ( $n = 41,438$  vs  $n = 30,570$ ). In contrast, the NEDS weighted estimate for nonfatal inpatient admissions was 3.7% and 2.1% higher in 2016 and 2018, respectively.

One possible explanation for the 2017 outlier is that one or more of the trauma centers responding to the 2017 Las Vegas mass shooting where over 400 were treated for gunshot wounds from a single event<sup>18,19</sup> was included in the

**Table 2.** Number, row proportion, and rate per 100,000 population by community characteristics for nonfatal firearm injury episodes for the United States, 2016-2018, based on emergency department discharges from the Nationwide Emergency Department Sample and inpatient hospital discharges from the National Inpatient Sample. Population from Healthcare Cost and Utilization Project files.

Category	Description	Total	Row proportion	Crude rate per 100,000
Hospital census region	Northeast	22,306	9.8%	13.22
	Midwest	52,736	23.1%	25.80
	South	114,224	50.0%	30.81
	West	39,113	17.1%	16.85
Patient residence urbanization	Large central metro	95,303	41.7%	31.48
	Large fringe metro	34,913	15.3%	14.40
	Medium metro	46,352	20.3%	22.72
	Small metro	19,547	8.6%	21.95
	Micropolitan	17,329	7.6%	21.05
	Noncore	12,657	5.5%	22.52
Patient ZIP median household income	Quartile 1 (lowest)	121,884	53.4%	50.04
	Quartile 2	50,737	22.2%	20.87
	Quartile 3	33,679	14.7%	13.68
	Quartile 4 (highest)	17,102	7.5%	7.09

NEDS sample of hospital EDs.<sup>2</sup> The weighting from the NIS sample of discharges, rather than hospitals, would not have been impacted to the same degree. In light of the differences in national weighted estimates from the choice of NEDS or NIS datasets, the switch from ICD-9 to ICD-10 coding that occurred mid-2015, and the short-term variations described here, further research to ensure that differences over time are not the result of methodology is needed before we can draw conclusions from data patterns.

The tens of thousands of Americans injured by firearms each year face many difficulties, including severe injury and hospitalization with its associated medical bills. The cost of nonfatal firearm injuries in 2013 has been estimated at \$2.5 billion for the medical treatment alone, with an additional \$23.5 billion for mental healthcare, police and criminal justice response, lost wages, and lost quality of life.<sup>20</sup>

The physical disability and costs of rehabilitation continue when discharged from the hospital. Analyses of the 2013–2014 HCUP Nationwide Readmissions Database found that 7.6% of patients hospitalized with nonfatal firearm injuries are readmitted within 30 days, and that patients with firearm injuries were more likely to be readmitted within 90 days following discharge compared to patients injured as either pedestrians or occupants in a motor vehicle collision.<sup>21,22</sup> On average, 9.5% of the cost of hospitalizations for nonfatal firearm injuries is due to readmission within the first six months of injury.<sup>23</sup> The trauma experienced can also have lasting impact for survivors of nonfatal gun injuries, even for those whose physical wounds heal completely. A follow-up survey of patients discharged from hospital with a gunshot wound found that, years after being shot, respondents had

lower reported measures of mental health, physical health, emotional support, and ability to participate in social roles. There were worse scores for patients with regard to alcohol use and substance abuse, and patients were more likely to screen positive for post-traumatic stress disorder.<sup>24</sup>

Importantly, hospital-based violence interventions programs have been shown to be cost saving while reducing the risk of further violent injury.<sup>25</sup> Similarly, interventions such as Counseling on Access to Lethal Means (CALM) have been successfully implemented in ED settings and may be an important tool in reducing the risk of firearm suicide.<sup>26</sup> The importance of lethal means counseling and reducing access to guns for persons at risk of suicide is clear from this analysis of nonfatal firearm injuries. Nearly two-thirds of gun deaths each year are by suicide, with the remaining one-third from homicide, yet intentional self-harm accounts for only 3% of the nonfatal firearm hospital discharges each year. The small number of persons seen as inpatients (5925) and even smaller number seen and discharged from the ED (1567) for nonfatal, intentional self-harm firearm injuries compared to the 71,224 firearm suicides for 2016–2018 points to the high lethality of firearms as a means for suicide.<sup>1,27</sup>

## LIMITATIONS

While NEDS and NIS are the largest and most representative samples of hospitalizations in the US, they are both just samples and not a full census of hospitalizations. As the differences between NEDS and NIS estimates of inpatient admissions and the differences between HCUP and CDC datasets show, included or excluded hospitals and communities can create a large difference in national

estimates. This analysis attempted to look across NEDS and NIS by dropping NEDS patients who had an outcome of inpatient admission or transfer to inpatient hospital and assuming that these patients were represented in NIS. If these patients were incorrectly coded in NIS as being subsequent rather than initial visits, the counts presented here would underestimate the burden of injury.

As with other analyses of external causes of injury, the ICD-10 codes may not accurately reflect the intent because of limited information at the time of the hospital encounter. In cases where the intent of a shooting injury is unclear, and in the absence of affirmative documentation on the incident, unintentional injuries may be overestimated and intentional self-harm and assault injuries may be underestimated.<sup>28</sup> NEDS and NIS also are both surveys of hospitalizations and exclude nonfatal firearm injuries that may have been managed in clinicians' offices or urgent care facilities separate from hospitals and therefore likely underestimate less severe injuries from firearms.

## CONCLUSION

There is a persistent and urgent need to understand nonfatal firearm injury episodes seen in EDs and as inpatients in hospitals across the United States. Nonfatal firearm injury episodes on average occur at a rate twice that of firearm deaths. This descriptive analysis points to large disparities in terms of the high rate and heavy burden of nonfatal firearm injury episodes particularly in low-income, urban communities and among Black adolescent boys and young men. Policies and interventions to reduce gun violence must focus on the most impacted communities and prioritize community- and evidence-based solutions that address these disparities.

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*Address for Correspondence:* Kathryn Schnippel, PhD, Everytown for Gun Safety Support Fund, P.O. Box 3886, New York, NY 10017. Email: kbistline@everytown.org.

*Conflicts of Interest:* By the WestJEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

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# Emergency Physician Survey on Firearm Injury Prevention: Where Can We Improve?

David A. Farcy, MD\*†

Nicole Doria, MD‡

Lisa Moreno-Walton, MD, MS, MSCRS§

Hannah Gordon, MD, MPH\*

Jesus Sánchez, PhD¶

Luigi X. Cubeddu, MD, PhD||

Megan L. Ranney, MD, MPH#

\*Mount Sinai Medical Center, Department of Emergency Medicine, Miami Beach, Florida

†Florida International University Herbert Wertheim College of Medicine, Department of Emergency Medicine & Critical Care, Miami Florida

‡Dalhousie University, School of Health and Human Performance, Halifax, Canada

§Louisiana State University Health Sciences Center, Department of Emergency Medicine, New Orleans, Louisiana

¶NOVA Southeastern University, Department of Socio Behavioral Sciences, COP, Davie, Florida

||NOVA Southeastern University, Department of Pharmaceutical Sciences, COP, Davie, Florida

#Brown University, Alpert Medical School, Department of Emergency Medicine, Providence, Rhode Island

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**Introduction:** Firearm injury and death is increasingly prevalent in the United States. Emergency physicians (EP) may have a unique role in firearm injury prevention. The aim of this study was to describe EPs' beliefs, attitudes, practices, and barriers to identifying risk of and counseling on firearm injury prevention with patients. A secondary aim was assessment of perceived personal vulnerability to firearm injury while working in the emergency department (ED).

**Methods:** We conducted a cross-sectional survey of a national convenience sample of EPs, using questions adapted from the American College of Surgeons' Committee on Trauma 2017 survey of surgeons. Descriptive statistics and chi-square tests were calculated as appropriate.

**Results:** A total of 1901 surveys were completed by EPs from across the United States. Among respondents, 42.9% had a firearm at home, and 56.0% had received firearm safety training. Although 51.4% of physicians in our sample were comfortable discussing firearm access with their high-risk patients, more than 70% agreed or strongly agreed that they wanted training on procedures to follow when they identify that a patient is at high risk of firearm injury. Respondents reported a variety of current practices regarding screening, counseling, and resource use for patients at high risk of firearm injury; the highest awareness and self-reported screening and counseling on firearm safety was with patients with suicidal ideation. Although 92.3% of EPs reported concerns about personal safety associated with firearms in the ED, 48.1% reported that there was either no protocol for dealing with a firearm in the ED, or if there was a protocol, they were not aware of it. Differences in demographics, knowledge, attitudes, and behavior were observed between respondents with a firearm in the home, and those without a firearm in the home.

**Conclusions:** Among respondents to this national survey of a convenience sample of EPs, approximately 40% had a firearm at home. The majority reported wanting increased education and training to identify and counsel ED patients at high risk for firearm injury. Improved guidance on personal safety regarding firearms in the ED is also needed. [West J Emerg Med. 2021;22(4.1):15-23.]

## INTRODUCTION

Firearm injury in the United States is a continuing epidemic.<sup>1,2</sup> In 2017 alone, there were 39,773 firearm-related deaths: 23,854 suicides; 14,542 homicides; 486 resulting from unintentional discharge of a firearm; and 338 of undetermined origin.<sup>3</sup> The rate of firearm death has increased 20% in the last five years.<sup>4</sup> Although firearm injury statistics are unreliable, the best available data estimates that in the last five years there were more than twice as many nonfatal firearm injuries seen in emergency departments (ED).<sup>5</sup> In 2018 and 2019, medical organizations joined together to assert the need for a public health approach to firearm injury, highlighting the need for research and describing ways in which the medical community could design and implement clinically-based firearm injury prevention initiatives.<sup>6,7</sup>

Physicians effectively risk stratify and counsel patients regarding preventive health including tobacco and alcohol cessation, correct use of infant car seats, the importance of wearing seatbelts and helmets, drowning prevention, and vaccinations.<sup>8-10</sup> Evidence suggests that similar risk stratification and counseling discussions may be effective for preventing firearm injury and its consequences.<sup>11</sup> Physicians can identify at-risk patients, provide factual information about firearm injury risk and, if needed, refer patients to resources that may reduce risk.<sup>12-14</sup> Contrary to the myth that patients resent being counseled on firearm safety by their doctors, the literature shows that patients are receptive to discussing firearm injury prevention with physicians, as long as counseling is delivered in a respectful manner.<sup>15,16</sup> While physicians who own firearms may be more likely to discuss firearm injury prevention with patients than those that don't,<sup>17</sup> in general, few physicians raise the subject with patients. This is true despite physicians in general believing they have the right to discuss firearm safety, and medical leadership groups and patients concurring and encouraging such discussions.<sup>18</sup>

There are approximately 150 million ED visits each year in the US.<sup>3</sup> Emergency physicians (EP) are not only the first (and sometimes only) physicians to treat patients with firearm injuries, we also have a well-documented role in identification and implementation of injury prevention strategies in general.<sup>19</sup> However, a recent study found that the charts of only 3% of patients presenting with suicidal ideation documented whether or not the patient had access to a firearm,<sup>20</sup> and according to a small, non-scientific survey in 2016, few EPs discussed risk of firearm injury with victims of domestic violence, assault, or other high-risk categories.<sup>21</sup> A survey of EPs in 22 states reported that although two-thirds of respondents had encountered a firearm in the ED, fewer than half felt at all confident in their ability to safely handle the situation.<sup>22</sup> These missed opportunities may be related to the paucity of education on this topic in medical schools, or due to other unmeasured factors.<sup>1,2</sup>

Prior work conducted by the American College of Surgeons described attitudes, beliefs, and practices of US

### *Population Health Research Capsule*

What do we already know about this issue?  
*Firearm injury and death is increasingly prevalent in the United States. Emergency physicians (EP) may have a unique role in firearm injury prevention.*

What was the research question?  
*What are EPs' beliefs, attitudes, practices, and barriers to identifying and counseling on firearm injury prevention.*

What was the major finding of the study?  
*EP's reported wanting increased education and training to identify and counsel ED patients at high risk for firearm injury.*

How does this improve population health?  
*Education, training, protocols and open dialogue between EPs and patients may improve screening and counseling of at-risk patients - and, potentially, reduce incidence of firearm injury and death.*

surgeons regarding firearms and firearm injury prevention, and was used to develop consensus recommendations on surgeons' roles in firearm injury prevention.<sup>23</sup> Given EPs' critical role in injury prevention, a similar assessment of EPs is warranted. The aims of this study were to assess EPs' knowledge, attitudes, and self-reported practice regarding firearm injury prevention, and to evaluate their perceived personal vulnerability to firearm injury in the workplace.

## MATERIALS AND METHODS

A cross-sectional survey, adapted from the previously published American College of Surgeons' Committee on Trauma (ACS-COT),<sup>23,24</sup> was endorsed and distributed by the American Academy of Emergency Medicine (AAEM), the Resident Student Association (RSA/AAEM) and the US Council of Residency Directors in Emergency Medicine (CORD-EM). The questionnaire was sent via email and online newsletters to a convenience sample of ~6000 US resident and attending EPs using an online survey tool (SurveyMonkey, San Mateo, CA); the exact number of recipients is unknown, due to unknown overlap between survey lists. The survey opened on June 26, 2019 and remained open until August 31, 2019.

A consensus panel of experts in emergency medicine (EM) developed the survey items based on a 2017 survey from the ACS-COT.<sup>23,24</sup> The final survey is available in Appendix 1. All authors reviewed, tested, and edited multiple iterations of the survey prior to approving the final version. No identifiers were incorporated to ensure the privacy of the respondents, and no

individuals were identified in the analysis or written results. No incentives were awarded for completion of the survey.

Descriptive statistics were expressed as the number of observations, percentages, means ± standard error of the mean (SEM), and 95% confidence intervals (CI). For ease of analysis and presentation, some questions with four or five category outcomes were collapsed into a dichotomous variable (e.g., “always or almost always” vs “neutral, rarely, never”; or “strongly agree or agree” vs “neutral, disagree, or strongly disagree”). We conducted chi-square tests of association to examine the association between reporting owning a gun or having a firearm in the home, and an array of study participants’ characteristics, beliefs, knowledge, and attitudes. SPSS version 26 (IBM Corp., Armonk, New York) was used for statistical analysis.

The study was given exempt status by the Institutional Review Board at Mount Sinai Medical Center, Miami Beach, Florida. This research was conducted without grant funding or support from any public, commercial, or non-profit source.

**RESULTS**

A total of 1901 respondents completed surveys, of whom 62.3% self-identified as men, 79.8% as White, and 64.3% as attending physicians (Table 1). All regions of the country were represented, with the highest proportion of responses (32.0%) from the Northeast. Three quarters (75.3%) of respondents identified their location of current practice or residency training site as a large city or a suburb near a large city. Most (86.1%) of the respondents were civilians without any military experience. Almost half (42.9%) reported having at least one firearm at home, of whom 84.8% personally owned the firearms (Table 1). More than half of participants (56.0%) had some prior training on firearm safety for personal use, more than half (57.1%) strongly agreed or agreed that personal ownership of firearms by private individuals in the US should be a constitutional right, and almost half (45.1%) strongly agreed or agreed that personal ownership of firearms protects personal liberty. Demographic differences were observed in who reported having a gun at home, with male (49.3%) and White (45.1%) respondents being more likely

**Table 1.** Demographics and characteristics of survey participants (N=1,901).

Characteristics	Total % (N)	Characteristics	Total % (N)
Gender (n = 1901)		Resident PGY 4	2.2 (41)
Male	62.3 (1,185)	Resident PGY 5	0.3 (5)
Female	36.0 (684)	Region of Practice (n = 1825)	
Rather not answer	1.5 (29)	Northeast	32.0 (584)
Other	0.2 (3)	Southeast	24.0 (438)
Race and Ethnicity (n = 1893)		Midwest	16.0 (292)
White	79.8 (1,511)	Southwest	14.0 (256)
Asian or Asian American	9.2 (174)	West	14.0 (255)
Hispanic/Latino	6.2 (118)	Location of Current Practice or Training (n = 1897)	
Other	3.8 (72)	Large city	54.9 (1,042)
Black or African American	3.7 (69)	Suburb near a large city	20.4 (386)
Middle East/North Africa	1.8 (34)	Small city or town	19.6 (371)
Native American or Alaska Native	0.7 (13)	Rural area	3.4 (65)
Level of Training in Emergency Medicine (n = 1898)		Other	0.9 (17)
Attending 1-5 year out of residency	23.1 (439)	Not currently in a clinical practice	0.8 (16)
Attending more than 16 years out of residency	15.9 (301)	Has military experience (previous or active)	13.9 (263)
Attending 6-10 years out of residency	15.5 (294)	No military experience (previous or active)	86.1 (1,635)
Resident PGY 1	13.3 (252)	Has training on firearms safety for personal purposes	56.0 (1,063)
Attending 11-15 years out of residency	9.9 (187)	No training on firearms safety for personal purposes	44.0 (835)
Resident PGY 3	9.9 (187)	Has firearms stored in home (even if not owner)	42.9 (806)
Resident PGY 2	7.9 (150)	Personal owner of firearm stored in home	84.9 (656)
Other	2.2 (42)	No firearms stored in home (even if not owner)	57.1 (1,074)

Notes: Total number of participants in study is N = 1 901. Participants could skip questions, which is why different questions have different n.

PGY, postgraduate year.

than women (30.3%), Hispanic (34.2%), and Black (22.8%) respondents, while rural (58.7%) and small town (51.9%) respondents reported being more likely to have a gun at home than respondents in large cities (38%) or suburbs (44.5%). Of respondents who considered gun ownership a constitutional right and a personal liberty, 81.0% and 85.9% reported having a gun at home. (Table 1).

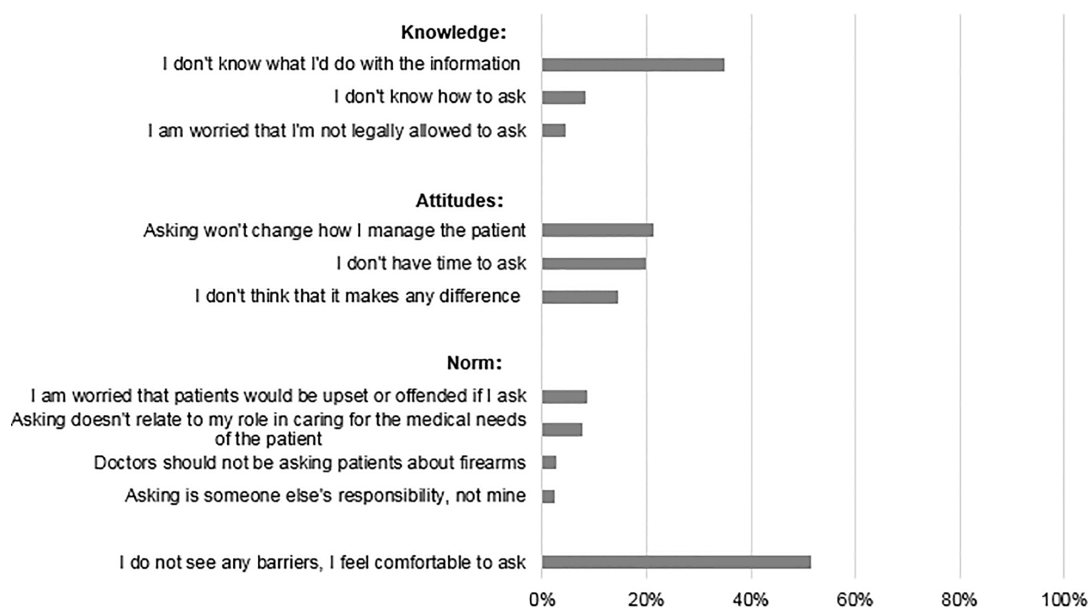
Regarding barriers to asking at-risk patients about firearms, most (51.4%) reported “no barriers to, or felt comfortable with, asking patients about firearm access” (Figure 1). Yet almost half (47.7%) reported lack of knowledge (e.g., “I don’t know what to do with the information”); more than half (55.8%) reported attitudinal barriers (e.g., “I don’t think it makes a difference”); and one-fifth (21.3%) reported negative attitudes and normative beliefs (e.g., “Asking is someone else’s responsibility, not mine”) about screening (Figure 1).

Respondents had a wide variety of beliefs about counseling on firearm injury prevention. Only a quarter (25.7%) of respondents “strongly agreed” or “agreed” that patients would change how they store their firearms if physicians educated patients on firearm injury prevention. Almost half (46.1%) said that they personally had the training necessary to educate/counsel patients on firearm injury prevention. Nonetheless, nearly three-quarters (71.0%) wanted additional training in procedures to follow for patients at risk, and only a quarter (24.8%) “strongly agreed” or “agreed” that EPs in general are knowledgeable about firearm injury prevention (Figure 2).

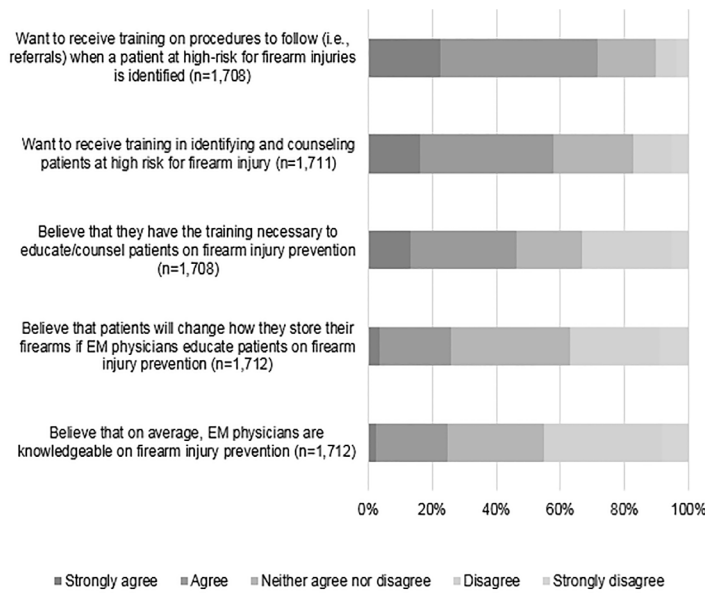
Self-reported frequency of asking patients about firearm access was dependent on the clinical scenario (Figure 3). Almost all (82.3%) EPs self-reported almost always or often asking a patient with suicidal ideation or suicide attempt (SI/SA) about

firearm access, compared to 52.4% of cases where patients presented as victims of domestic violence, and lower rates for patients with psychosis or intoxication (11.7%). Knowing that a patient had access to a firearm would reportedly increase concern of future risk of violence or self-harm for 91.7% for suicidal patients, vs only 46.6% of assault-injured patients (Figure 4). Knowing that a patient had access to a firearm would change an EP’s assessment of a patient only rarely, except for suicidal or psychotic patients (Figure 5). When asked about counseling, however, less than half (46.9%) of respondents reported “almost always” or “often” counseling suicidal patients and their families on lethal means.

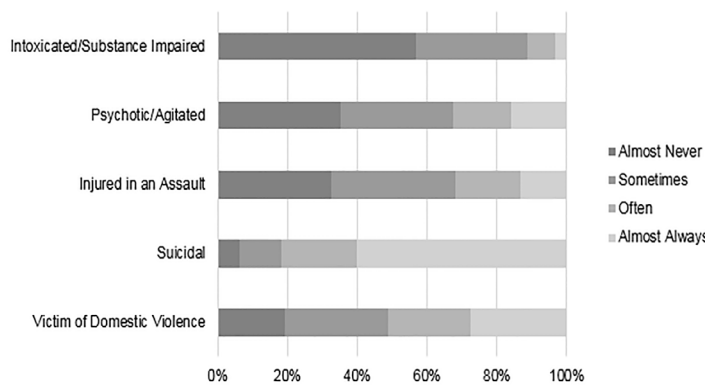
Differences in responses were observed between respondents with a firearm in the home, and those without a firearm in the home. Although the majority (79%) of respondents with a firearm in the home believed that they had the training necessary to educate/counsel patients on firearm injury prevention, only 38.1% believed that other EPs were knowledgeable on firearm injury prevention. Of the EPs who strongly agreed that they wanted additional training in procedures to both identify and counsel patients at risk, only 26.4% and 22.9%, respectively, were gun owners (vs 73.6% and 77.1% non-gun owners;  $P<0.0001$ ). Of EPs who strongly agreed that counseling would change how patients stored their firearms, only 34.4% were gun owners (vs 65.6% non-gun owners;  $P<0.0001$ ). Compared to those without a firearm in the home, respondents with a firearm in the home were less likely to report that knowing a patient had firearm access changed their assessment about their risk of future violence/self-harm for a victim of domestic violence (30.6 vs 69.4%), a suicidal patient (38.2% vs 61.7%), an assault-injured patient (27.2% vs 72.8%), a psychotic/agitated patient (37.1%



**Figure 1.** Participants were asked which of these are significant knowledge, attitudinal, and norm-related barriers to personally asking patients about firearm access. (Total n = 1,701.)



**Figure 2.** Participants agreement with the statements about training in firearm injury prevention (on a scale from strongly agree to strongly disagree). EM, emergency medicine.



**Figure 3.** Frequency of asking a patient about firearm access in different scenarios. (Total n = 1,710)

vs. 62.9%), or an intoxicated/substance impaired patient (27.9% vs 72.1%) ( $P<0.001$ ). Yet respondents with firearms in the home more frequently reported asking about lethal means compared to non-gun owners (almost never asked: gun-owners 68%; non-gun owners: 32%;  $P<0.0001$ ).

When asked, “How big a concern for you is your personal safety associated with firearms while you are working in the ED?,” only 7.7% responded “no concern at all”; 25.3% expressed “very great concern”; 36.8% expressed “moderate concern”; and 30.1% expressed “some concern.” Almost 40% (n = 654) of EPs responded that they did not know whether their ED had a procedure for securing patient firearms, and 9.8% said that no protocols existed. Respondents with a firearm in the home were less likely to report concern about their personal safety while

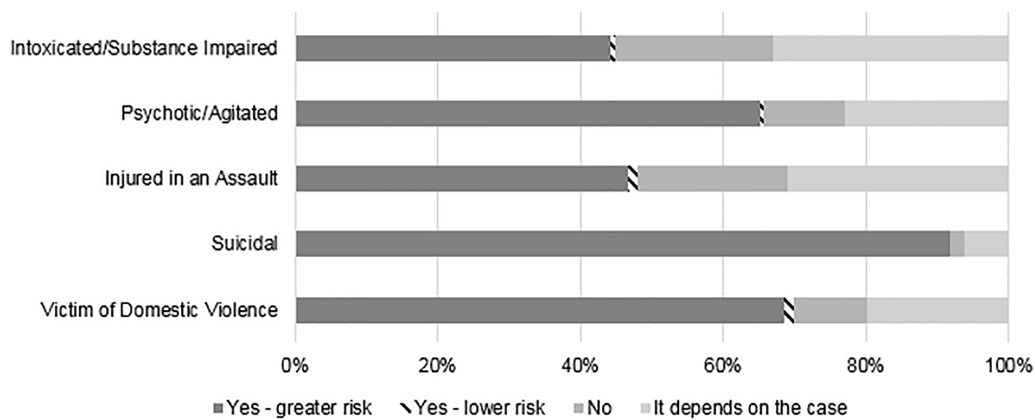
working at the ED (very great concern: 35.9% gun owners vs 64.1% no gun owners,  $P<0.0001$ ).

**DISCUSSION**

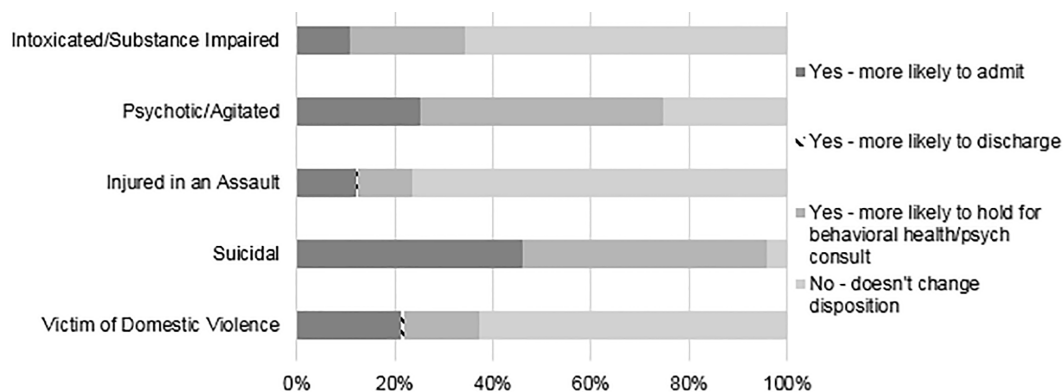
To our knowledge, this study is the most comprehensive assessment to date of EPs’ attitudes, beliefs, and self-reported behaviors in relation to firearm injury prevention in the clinical setting. Despite respondents representing a convenience sample, the percent of respondents with a firearm in their home is similar to that reported in national surveys, and the geographic, gender, and racial/ethnic distribution of the respondents is similar to that in national data on emergency medicine.<sup>22</sup> Among this diverse sample of EPs, despite half reporting no barriers to asking high-risk patients about firearm access, numerous training needs were identified. The most notable findings were the disparities between reported knowledge, attitudes, and normative beliefs about the values of screening vs actual reported counseling of high-risk patients. There were stark disparities between what respondents said they did, and what others did. Differences in knowledge, attitudes, and beliefs about screening and counseling were also observed between firearm owners and non-owners.

Reassuringly, our survey identifies that neither knowledge nor normative beliefs are major barriers to firearm injury screening and counseling for high-risk patients. Most respondents reported knowing how to ask, and most reported that a positive finding would affect their judgment (but not necessarily their behavior) regarding evaluation of an at-risk patient. Only 8.6% reported being afraid to ask a patient about access to a firearm. This finding differs from other surveys of other physicians’ knowledge and attitudes, which reported low rates of knowledge about the incidence of firearm injury and discomfort with asking about firearms.<sup>25</sup> This difference may reflect multiple medical societies’ educational efforts over the last half-decade emphasizing that patients are open to respectful, non-judgmental discussions of firearm injury risk.<sup>26,27</sup>

According to this survey, the two primary barriers to EPs’ effectively screening and counseling ED patients about firearm injury were not knowing how to respond to the information, and not thinking it will change management. Lack of resources, and skepticism about efficacy has been identified by others<sup>22,25-28</sup> as common barriers to effective firearm injury prevention in the ED. Our findings, therefore, reinforce the importance of physician and patient self-training resources and handouts. In 2019, Pallin et al published a guide to when and how to intervene to reduce firearm injury.<sup>11</sup> In response, multiple resources have been recently developed, including the following: 1) “What You Can Do” and “BulletPoints,” initiatives from University of California at Davis<sup>29</sup>; 2) “Gun Safety and Your Health” (available in both English and Spanish) from the American College of Surgeons<sup>30</sup>; 3) Guides to home firearm safety and pediatric counseling from the Firearm Safety Among Children and Teens (FACTS) Consortium<sup>31</sup>; 4) safe storage resources from the Colorado Firearm Safety



**Figure 4.** Knowledge of a patient's firearm access changes assessment of risk of harm. (Total n=1,711)



**Figure 5.** The proportion of participants that changed their assessment about a patient's risk of future violence/self-harm if the patient was intoxicated/substance impaired (n = 1,704), psychotic/agitated (n = 1,704), injured in an assault (n = 1,703), suicidal (1,710), and/or a victim of domestic violence (1,707). Total participants who answered this question n = 1,711.

Coalition<sup>32</sup>; and 5) a compendium of resources from the American Foundation for Firearm Injury Reduction in Medicine (AFFIRM), a non-partisan network of health professionals dedicated to changing the conversation about firearm injury prevention.<sup>33</sup> Emergency departments interested in decreasing barriers to screening and intervention could review and share these well-developed resources.

In line with national surveys, having a firearm in the home was more common among White men, those practicing in rural areas and small cities/towns, and those who believe that gun ownership is a constitutional right, a personal liberty, and a self-protection.<sup>34</sup> Those EPs with a firearm in the home were more likely to ask patients about lethal means, reported less concerns about their safety while working at the ED, were less interested in wanting additional training to identify patients at risk, and were less likely to agree that counseling would change how patients stored their firearms. Additionally, EPs with a firearm in the home were less likely than those without a firearm in the home to report insufficient knowledge about how to ask. These findings concord with our and others' work showing that

firearm owners can help lead evidence-based interventions to reduce firearm injury risk.<sup>22,28,35-37</sup> Future educational programs should make an effort to highlight the voices, expertise, and experience of firearm-owning EPs.<sup>37,38</sup> Nonetheless, deficits in knowledge were identified among this group, including lack of belief in the value of screening or counseling for patients who were at risk of non-suicide-related firearm injury.

The findings also suggest, unfortunately, that simple knowledge alone is unlikely to change behavior. For example, despite most participants reporting that screening is important and would change their behavior, and most respondents saying that they personally were comfortable with firearm counseling, almost all said that *other* EPs were not comfortable screening or counseling at-risk patients, and most requested at least some additional training for themselves. Similarly, despite most participants reporting that they "always or almost always" screen suicidal patients for firearm access (much higher than previous literature has reported),<sup>20,26,39</sup> and most participants reporting that this knowledge would change their disposition decision for suicidal patients, less than half report delivering

lethal means counseling. These incongruities may reflect social desirability bias (e.g., it may be easier for respondents to admit that others were unsure of what to do or how to do it, compared to admitting it about themselves). Others' work has studied physicians' actual behavior, using both electronic health records and self-report, and has similarly found that physicians screen far less often than self-report.<sup>11,26,39,40</sup> Even if a large percentage of subjects in this study are asking patients with suicidal ideation about firearm access, competent counseling should be part of the discussion.<sup>20</sup>

The contradictions in responses may reflect a key lesson of behavior change theory<sup>41,42</sup> and dissemination and implementation research: Attention must be paid to not just internal factors, but also healthcare and societal structures that influence change.<sup>42</sup> For example, Runyan et al have suggested that having departmental written protocols for lethal means counseling has been associated with a higher rate of counseling for all suicidal patients, and that developing such standard protocols across the country might increase lethal mean counseling.<sup>40</sup> Betz et al have developed physician-independent, web-based, lethal means counseling resources, with high acceptability and feasibility.<sup>43</sup> Development and dissemination of similar resources that reduce physician burden and address physician-independent barriers may be necessary.

Finally, our data confirm that EPs were significantly concerned about their safety associated with firearms while working in the ED, with a quarter expressing "very great" and more than a third expressing "moderate concern" about their personal safety. This concern is exacerbated by both a lack of policy regarding firearm handling, and a lack of knowledge of any existing policies; the majority of respondents reported that they are concerned for their own safety, yet a third had no idea whether a policy existed. This finding could potentially be explained by several factors including physicians' attitude toward the subject, professional priorities, or a lack of education or communication on the topic from ED leadership. In a survey conducted by Ketterer et al, 20% of attending and 25% of resident physicians reported encountering firearms in the ED or its immediate surroundings. Attending physicians, however, had more knowledge of hospital policy regarding handling and management of the firearm once it was discovered in a patient's possession, as compared to residents.<sup>22-28</sup> In another study Ketterer et al reports that "up to 25% of trauma patients brought to the emergency department (ED) have been found to carry weapons."<sup>28</sup> Overall, more research is needed to address safety in the ED and the handling of firearms when they are brought into the department; further collaborative work is needed.<sup>24,45</sup>

The American College of Surgeons' Committee on Trauma<sup>23</sup> published results from a similar survey of surgeons in 2016, with the primary objectives of identifying advocacy initiatives and efforts related to firearm safety. Our respondents were similar to ACS' in demographics, percent firearm ownership, percent with gun safety training, and percent with a military background; the one major difference is that our EM

survey included resident physicians, while the ACS survey did not. ACS found that the vast majority of respondents believed that healthcare professionals should be allowed to counsel patients on firearm safety and injury prevention, with 88% setting injury prevention as a high priority and 94% responding that federal funding should be allocated for firearm safety and injury prevention research.<sup>23</sup> Our study, conducted two years later after extensive educational work by both ACS and EM professional societies,<sup>7,45</sup> assumed that healthcare professionals have the duty to discuss firearm safety and injury prevention with at-risk patients, and sought instead to determine how often these conversations were taking place (< 50% of encounters with suicidal patients), how comfortable physicians were in having these conversations (51.4%), and what percentage of physicians felt the need for further training to effectively engage patients in these conversations (>70%).

The overarching theme of our organizations, institutions and collaborations is to explore shared goals among healthcare professionals, public health researchers, educators, advocates, firearm owners, gun shops,<sup>46</sup> and law enforcement officials who are collectively committed to working toward suicide prevention and firearm safety.<sup>32</sup> Our study supports the need for increased training and protocols regarding firearm counseling, handling, and medical record documentation. Physicians are aware of the lack of training and are open to learning the necessary skills to save lives through education and prevention of firearm injuries. Further research is needed on the efficacy of current training and available resources.

## LIMITATIONS

Selection bias is always present when a survey is sent to one or more large organizations by email; it is likely that respondents have stronger feelings or opinions about the survey topic. Another limitation associated with survey studies is the potential for over- or under-reporting of results due to inaccuracies attributable to social desirability or recall biases. However, social desirability bias has been shown to be less likely to occur with online surveys, such as ours, where no personal identifiers are involved and responses are more accurate than those obtained from face-to-face or telephone surveys.<sup>47,48</sup> This study is subject to a geographic bias, since most respondents were from the East coast of the US, although geographic bias is far more likely to impact results when surveys are done in various countries whose socioeconomic, religious, and political climates may vary considerably.

## CONCLUSION

Emergency physicians, whether firearm owners or not, believe in the importance of screening and counseling to reduce risk of firearm injury among at-risk patients. Nonetheless, further training, resources, and innovative interventions are needed to aid EPs in accurate identification and management of these high-risk patients. Additional resources are also needed to increase knowledge about personal safety from firearm injury in the ED.

**Address for Correspondence:** David A. Farcy, MD, Mount Sinai Medical Center, Department of Emergency Medicine, 4300 Alton Road, Miami Beach, FL 33140. Email: dfarcy@msmc.com.

**Conflicts of Interest:** By the WestJEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

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# The Bullets He Carried

Stephen W. Hargarten, MD, MPH

Medical College of Wisconsin, Comprehensive Injury Center, Milwaukee, Wisconsin

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The Sandy Hook Elementary School mass shooting on December 14, 2012, killed 26 people including 20 young children ages six to seven. The Sandy Hook shooter fired 154 bullets in less than four minutes, or about 38 bullets per minute from a semiautomatic rifle.

When the bullet leaves a Bushmaster rifle, it travels over 2000 feet per second. This velocity gives this bullet its devastating wounding potential. As this rifle bullet penetrates a human body, the energy of the bullet tears and shreds through tissue and bone, resulting in fractures, ruptured livers, and swollen brains, leading to hemorrhage, shock, and death. As an emergency physician, I have cared for hundreds of patients injured by bullets. I have had to tell parents that their teenager has died. Even those who survive are forever maimed and suffering. As a physician, I am interested in better understanding this pathogen of gun violence: the bullet and the guns that carry them.<sup>1</sup>

Recently, my colleagues and I at the Medical College of Wisconsin's Comprehensive Injury Center focused our attention on the bullet and its energy. This energy is a measure of the potential for causing wounds. Other factors play a role in wounding including the mass of the bullet and the direct tearing of tissues. But understanding the energy of a bullet and its wounding potential can help develop better treatment of the wounds.

Using the latest in high-speed video cameras, we discharged bullets through gelatin, which is commonly used to mimic human tissue. We measured the kinetic energy release of a modern, high-speed rifle bullet, and of a musket ball similar to those used in the 1780s (<https://www.mcw.edu/departments/comprehensive-injury-center/research>). Note the dramatic difference in speed, cavitation, wave propagation, and resultant tissue damage of the rifle bullet vs the musket ball. We found that the rifle bullet's energy release was over nine times greater than the musket ball because of the rifle bullet's significantly greater velocity compared to the musket ball's velocity.

In 1789, when the Second Amendment was passed by Congress, the average number of musket balls that could be fired by a member of the militia was about two per minute. Using this number-of-bullets-released-per-minute comparison, the Sandy Hook mass shooter represented the equivalent of 19 militiamen storming the elementary school. Even worse, the energy of the

rifle bullet released by the Sandy Hook mass shooter was in turn at least nine times greater per bullet than the energy released by the musket balls shot by the militia. Using this energy-release-per-minute calculation, and its accompanying wounding potential, the number of bullets and their energy fired by the Sandy Hook shooter equaled an estimated 171 militiamen storming the school. The rifle and bullet technology of 2020 far exceeds that available 230 years ago. When Congress passed the Second Amendment, they could not have anticipated that, in 2012, a single man in Connecticut would use a weapon with the killing power of an army of 171 members of the Connecticut militia.

Understanding and addressing today's bullets, their energy, their wounding potential, and the weapons that carry them are essential elements in any comprehensive solution to gun violence. It is of critical importance that all sectors of civil society understand this energy focus when discussing policies about these bullets and the guns that carry them.

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*Address for Correspondence:* Stephen W. Hargarten, MD, MPH, Medical College of Wisconsin, Department of Emergency Medicine, 8701 W. Watertown Plank Rd, Milwaukee, WI 53226. Email: [Hargart@mcw.edu](mailto:Hargart@mcw.edu).

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# California ACEP Firearm Injury Prevention Policy

**Jorge Fernandez, MD**  
**Taylor Nichols, MD**  
**Zahir Basrai, MD**  
**Randall Young, MD**  
**Michael Gertz, MD**  
**Marc Futernick, MD**  
**Andrew Fenton, MD**

University of California, San Diego, Department of Emergency Medicine, San Diego, California

*Section Editor:* Mark I. Langdorf, MD, MHPE

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Firearm-related deaths and injuries are a serious public health problem in California and the United States. The rate of firearm-related deaths is many times higher in the US than other democratic, industrialized nations, yet many of the deaths and injuries are preventable. The California American College of Emergency Physicians Firearm Injury Prevention Policy was approved and adopted in 2013 as an evidence-based, apolitical statement to promote harm reduction. It recognizes and frames firearm injuries as a public health epidemic requiring allocation of robust resources, including increased governmental funding of high-quality research and the development of a national database system. The policy further calls for relevant legislation to be informed by best evidence and expert consensus, and advocates for legislation regarding the following: mandatory universal background checks; mandatory reporting of firearm loss/theft; restrictions against law-enforcement or military-style assault weapons and high capacity magazines; child-protective safety and storage systems; and prohibitions for high-risk individuals. It also strongly defends the right of physicians to screen and counsel patients about firearm-related risk factors and safety. Based upon best-available evidenced, the policy was recently updated to include extreme risk protection orders, which are also known as gun violence restraining orders. [West J Emerg Med. 2021;22(4.1):25–28.]

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Firearm-related injuries and deaths are a serious public health problem in the United States (US), yet the idea of regulating firearm ownership and access is complicated, politically charged, and potentially conflicts with US Constitution 2nd Amendment rights. The rate of firearm-related deaths is many times higher in the US than in other democratic, industrialized nations.<sup>1</sup> In 2015, there were 113 firearm deaths per million individuals in the US as compared with 0.8 in the United Kingdom.<sup>1,2</sup>

Despite this disparity, and largely due to politics, firearm violence prevention research receives significantly less US federal funding compared with other leading causes of death; yet available research suggests that many firearm-related injuries and deaths are preventable.<sup>3,4,5,6</sup> A 1993 study published in the *New England Journal of Medicine* and funded by the US Centers for Disease Control and Prevention

(CDC) identified an association between elevated homicide risk within homes with guns. In response, the National Rifle Association (NRA) successfully lobbied US Congress in 1996 to include the “Dickey Amendment” in the federal omnibus spending bill.<sup>7</sup> That amendment stripped \$2.6 million from the CDC’s budget (the amount it had spent on firearm research the previous year) and added the following language: “none of the funds made available for injury prevention may be used to advocate or promote gun control.” Thereafter, federal firearm safety and violence research funding at the CDC, and later the National Institutes of Health (NIH), was effectively eliminated.<sup>8</sup> A 2013 report from the Institute of Medicine concluded, “the scarcity of research on firearm-related violence limits policymakers’ ability to propose evidence-based policies that reduce injuries and deaths and maximize safety.”<sup>9</sup> Using a methodology that calculated

expected levels of research investment based on mortality rates, one study estimated that between 2004 and 2015 firearm violence prevention research received just 1.6% of the federal research support projected, and had just 4.5% of the volume of publications anticipated.<sup>10</sup> Congress in 2018 clarified that the CDC can conduct research into firearm injury prevention, but again cannot use government funds to specifically advocate for gun control. Subsequently, the 2020 federal omnibus spending bill specifically allocated \$25 million to the CDC and NIH toward firearm violence prevention research.<sup>11</sup>

Founded in 1971, the California Chapter of the American College of Emergency Physicians (California ACEP) is a 501(c)(6) non-profit, non-partisan, association representing California's board-certified emergency physicians (EP). California ACEP's mission is to support EPs in providing the highest quality of care to all patients and to their communities. In 2000, the California ACEP board of directors (BOD) voted to make firearms injury prevention one of the organization's legislative priorities and approved a position statement concerning firearm injury prevention. In 2013, multiple bills regarding mandatory firearm restrictions were proposed to the California State Senate and Assembly. The California ACEP BOD tasked a subcommittee with reviewing the chapter's position statement and available research, updating the chapter's official policy, and guiding its legislative and advocacy efforts. The California ACEP Firearm Injury Prevention Policy (Firearm Policy) was approved and adopted in 2013 as an evidence-based, apolitical statement to promote harm reduction. The Firearm Policy recognizes and frames firearm injuries as a public health epidemic requiring allocation of robust resources, including increased government funding of high-quality research and the development of a national database system of firearm injuries. The policy further calls for legislation to be informed by best evidence and expert consensus, and advocates for legislation focused on the following:

1. Mandatory universal background checks
2. Mandatory reporting of firearm loss/theft
3. Restrictions against law-enforcement or military-style assault weapons and high capacity magazines
4. Child-protective safety and storage systems
5. Prohibitions against gun possession or purchase for high-risk individuals
6. The right of physicians to screen and counsel patients about firearm-related risk factors and safety.

In a subsequent review of the scientific literature on the effects of firearm injury prevention policies, the RAND Corporation cited evidence supporting child-access prevention laws, mandatory waiting periods, universal background checks, prohibitions related to domestic violence and mental illness, along with minimum age and licensing/permitting requirements.<sup>6</sup> Notably, all these recommendations are

included in the Firearm Policy.

In 2016, in response to recent highly publicized mass shootings including San Bernardino and Sandy Hook, the state of California overwhelmingly passed Proposition 63 (63% in favor vs 37% opposed).<sup>12</sup> Proposition 63 focused mainly on the regulation of ammunition. It mandated a universal background check and California Department of Justice authorization to purchase ammunition (in addition to firearms, which was already regulated), and it specifically prohibited *possession* of large capacity magazines (LCM), which hold more than 10 rounds of ammunition. Prior to Proposition 63, it had been illegal in California to manufacture, purchase, receive, import, keep, sell, give, or lend LCMs. Proposition 63 also levied fines against firearm owners who fail to report the theft or loss of their firearm.<sup>13</sup> Several regulations in Proposition 63, including a ban on LCM possession and mandatory reporting of firearm loss or theft, were advocated by the Firearm Policy. The NRA subsequently sponsored a legal challenge to Proposition 63 (*DUNCAN v BECERRA*),<sup>14</sup> and in March 2019, the District Court for the Southern District of California ruled that Proposition 63 was unconstitutional, despite testimony by EPs on behalf of California ACEP. On August 14, 2020, a divided three-judge panel of the Ninth District Federal Court of Appeals upheld the federal district court's ruling. That decision is currently being further appealed,<sup>15</sup> and the case is being closely tracked by California ACEP's BOD and staff.

Another crucial firearm-related violence prevention policy topic recently reviewed by the California ACEP BOD concerns extreme risk protection orders (ERPO), which are also known as gun violence restraining orders. In many states including California, medical professionals, law enforcement officers, coworkers, teachers, and family members may petition a court for ERPOs, which preemptively and temporarily authorize law enforcement officers to remove firearms from individuals deemed high risk for self-harm or violence against others. ERPO laws often allow formal court appeal and forbid harassment, to prevent misuse of ERPOs that could restrict access to firearms for defense, hunting, or recreation.<sup>16</sup> Several studies examining ERPOs in states outside of California suggest that they are modestly effective in reducing firearm-related suicides.<sup>17</sup> Per a RAND analysis, there were limitations in these studies, including the extrapolation of suicide attempts, rather than observed data, and a lack of comparison groups.<sup>6</sup> However, the data was convincing enough to move the chapter's BOD in 2020 to include ERPOs in an update to the Firearm Policy.

California ACEP strongly believes that it should advocate for evidence-based solutions to public health and policy issues, including firearm violence prevention and safety. Clearly, preventing injuries and deaths is more effective than, and preferable to, heroic saves in the emergency department or trauma bay. The Firearm Policy promotes evidence-based legislative recommendations and highlights the urgent need

for more robust government funding, data, and evidence to effectively address the firearm violence epidemic in California and the US.

### California ACEP Firearm Injury Prevention Policy:

It is the position of the California Chapter of the American College of Emergency Physicians that:

1. Emergency Medicine is well positioned, as a profession and specialty, to appreciate the multifaceted ramifications of firearm injuries in our society. Firearm violence is a public health epidemic that can only be effectively cured by deploying necessary and appropriate resources.
2. California ACEP deplores attempts to politicize or silence physicians and science on firearm violence. We recommend robust funding (federal and otherwise) of research on firearm injury and evidence-based prevention as well as its impact on public health and safety. It is our hope and belief that such research will guide better future legislation and lead to well-informed public policy.
3. Legislative measures and policies to curb or reduce firearm violence should be informed by evidence-based consensus. We advocate for continued research and implementation of programs focused on the safe storage of legitimate firearms, development of childproof or personalized guns, prevention of both interpersonal and self-directed violence by firearms, including the prevention of gang-related and domestic violence.
4. We support mandatory, comprehensive, and universal background checks for the purchase of firearms. Background checks should be required for essentially all firearm transfers, including at gun shows and auctions and from private sellers. Prohibited straw purchases of firearms should be recognized as serious crimes and be treated as such, and all secondhand gun sales and firearm transfers should be regulated. We support continued efforts to improve the quality of the data on which background checks are performed, such that all prohibited persons can be detected.
5. We support requiring that all firearm owners of record be required to report the theft or loss of their firearm within a timely period of becoming aware of such a loss.
6. We recommend legislation banning civilian purchase or access to assault weapons, large-capacity ammunition magazines, and any munitions specifically designed for the use by military and law enforcement agencies.
7. We encourage all healthcare providers, including emergency physicians, to screen and counsel patients with diagnosed mental illnesses or believed to be at risk of harming themselves or others for their potential access to firearms, and to refer such patients to appropriate mental health services in a timely manner. Policies and procedures for this process need to be validated and standardized.
8. We recommend the creation of a national database and

surveillance system to track firearm-related injury and mortality, including mandatory reporting of firearm injuries and fatalities by all hospitals and healthcare centers.

9. We support restraining orders that allow for the removal of a firearm to provide a rapid, focused response when risk for imminent firearm violence, including suicide and homicide, is high. We support restraining orders that rely on actions by judicial officers and include due process protections and provide for immediate firearm recovery and include a prohibition on possession and purchase of firearms and ammunition. We support allowing petitions for such orders to be submitted by family members, law enforcement officers, physicians, and other mental health professionals including school counselors.
10. We recommend prohibiting firearm purchases by individuals in high-risk categories that include but are not limited to habitual criminals, drug traffickers, persons with mental illness who are suicidal or high risk, those with violent misdemeanors, persons with multiple convictions for alcohol-related offenses, those with a history of domestic violence, juveniles convicted of violent crimes, and violators of parole and restraining orders.
11. We believe in the protection of healthcare providers' rights to educate patients regarding firearm safety. We encourage all healthcare providers, including emergency physicians, to counsel patients about firearm safety when appropriate including discussing with parents safe storage of firearms in homes with children.

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*Address for Correspondence:* Jorge Fernandez, MD, UC San Diego Health, 200 W. Arbor Drive, MC8676, San Diego, CA 92103. Email: jaf014@health.ucsd.edu.

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# Patterns and Predictors of Firearm-related Spinal Cord Injuries in Adult Trauma Patients

Dina Mahmassani, MD  
Rana Bachir, MD  
Mazen El Sayed, MD, MPH

American University of Beirut Medical Center, Department of Emergency Medicine,  
Beirut, Lebanon

Section Editor: Mark I. Langdorf, MD, MHPE

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**Introduction:** Firearm-related spinal cord injuries are commonly missed in the initial assessment as they are often obscured by concomitant injuries and emergent trauma management. These injuries, however, have a significant health and financial impact. The objective of this study was to examine firearm-related spinal cord injuries and identify predictors of presence of such injuries in adult trauma patients.

**Methods:** This retrospective cohort study examined adult trauma patients ( $\geq 16$  years) with injuries from firearms included in the 2015 United States National Trauma Data Bank. We performed descriptive and bivariate analyses and compared two groups: patients with no spinal cord injury (SCI) or vertebral column injury (VCI); and patients with SCI and/or VCI. Predictors of SCI and/or VCI in patients with firearm-related injuries were identified using a multivariate logistic regression analysis.

**Results:** There were 34,898 patients who sustained a firearm-induced injury. SCI and/or VCI were present in 2768 (7.9%) patients. Patients with SCI and/or VCI had more frequently severe injuries, higher Injury Severity Score (ISS), lower mean systolic blood pressure, and lower Glasgow Coma Scale (GCS). The mortality rate was not significantly different between the two groups (14.7%,  $N = 407$  in SCI and/or VCI vs 15.0%,  $N = 4,811$  in no SCI or VCI group). Significant general positive predictors of presence of SCI and/or VCI were as follows: university hospital; assault; public or unspecified location of injury; drug use; air medical transport; and Medicaid coverage. Significant clinical positive predictors included fractures, torso injuries, blood vessel or internal organ injuries, open wounds, mild (13-15) and moderate GCS scores (9 – 12), and ISS  $\geq 16$ .

**Conclusion:** Firearm-induced SCI and/or VCI injuries have a high burden on affected victims. The identified predictors for the presence of SCI and/or VCI injuries can help with early detection, avoiding management delays, and improving outcomes. Further studies defining the impact of each predictor are needed. [West J Emerg Med. 2021;22(4.1):29–36.]

## INTRODUCTION

### Background

Firearm-related injuries continue to have a significant health and financial impact worldwide. In the United States (US), mass shootings are responsible for increasing proportions of total firearm-related homicidal deaths.<sup>1</sup> In 2017, the rate of nonfatal, firearm-related gunshot injuries was 41.1 per 100,000 injured.<sup>2</sup> The fatality rate of firearm-related

gunshot injuries was 12.2 per 100,000 injuries.<sup>3</sup> Between the years 2006 and 2010, a total of 385,769 emergency department (ED) visits secondary to firearm-related injuries yielded 141,914 inpatient admissions with an estimated cost of more than 88 billion US dollars.<sup>4</sup>

Firearm injuries can result in a myriad of health outcomes, with both short- and long-term sequelae, including spinal cord injuries (SCI). Firearms are the main cause of traumatic

spinal cord injuries in Brazil (28.4%). This rate varies from one country to another, dropping down to 8.4% in Thailand and as low as 1.9% in Turkey.<sup>5-7</sup> In the US, 12.2% (784 out of a total of 17,730 new annual SCIs) are secondary to gunshot injuries.<sup>8,9</sup> Spinal cord injuries also result in a significant health and financial burden at the level of the individual patient and their families, as well as at the level of the healthcare system. Less than 1% of affected individuals achieve complete neurological recovery upon hospital discharge, with the most frequent sequela being incomplete tetraplegia. Mortality rates are also highest during the first year post-injury.<sup>10</sup>

In contrast to most injuries that take priority in the management of trauma cases, SCIs can often be missed initially and not detected until later in the management process via imaging. They are often obscured by the presence and/or need to manage more life-threatening concomitant injuries, particularly severe head trauma or hemorrhage, in addition to the performance of emergent procedures such as intubation, sedation, and surgical procedure.<sup>6,11-12</sup>

### Importance

This is the first study to identify general and clinical predictors of firearm-induced SCI and/or vertebral column injury (VCI), which would serve as cues for earlier detection and management of SCI/VCI.

### Objectives

This study examines firearm-related spinal cord injuries in adult trauma patients in the US and identifies predictors of presence of such injuries in this patient population.

## METHODS

### Study Design and Setting

For this retrospective cohort study we used the public release dataset from the 2015 National Trauma Data Bank (NTDB). This dataset is an annually issued, US population-based, multicenter cohort and is considered the largest aggregation of US-based trauma registry data.<sup>13</sup> The institutional review board at the American University of Beirut approved the use of the de-identified dataset to conduct this study.

### Selection of Participants

The total number of patients in the dataset was 917,865. The study sample included adult patients ( $\geq 16$  years) who sustained firearm-induced injury coded under a list of *International Classification of Diseases, Ninth Revision* E codes "Mechanism" (Appendix) (N = 34,898). We excluded pediatric patients (age < 16 years, similar to other trauma studies<sup>14</sup>) and cases with missing age documentation (Figure).

### Analysis

We conducted descriptive analyses to summarize the categorical variables by calculating their frequencies and

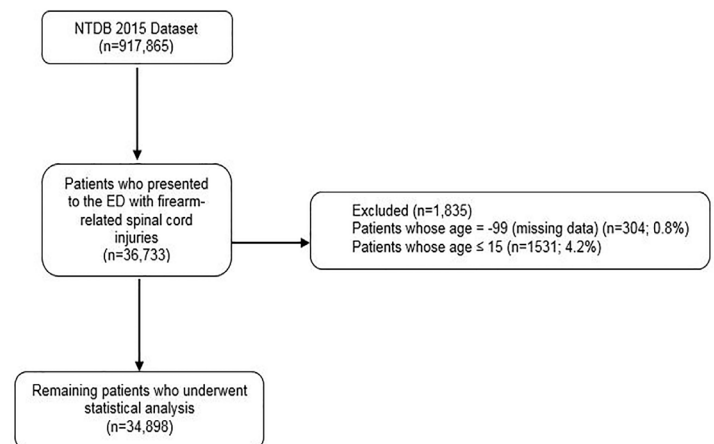
### Population Health Research Capsule

What do we already know about this issue?  
*Firearm-related spinal cord injuries (SCI) are commonly missed in the initial assessment as they are often obscured by more life-threatening injuries.*

What was the research question?  
*This study examines firearm-related SCI in adult trauma patients and identifies predictors of such injuries.*

What was the major finding of the study?  
*SCI and/or vertebral column injury (VCI) were present in 7.9% of adult patients with trauma. Several clinical and non-clinical predictors were identified.*

How does this improve population health?  
*The identified predictors can help with early detection of SCI/VCI injuries, avoid management delays, and improve outcomes of trauma patients.*



**Figure 1.** Flowchart showing inclusion and exclusion of patients with firearm-induced injuries. NTDB, National Trauma Data Bank ; ED, emergency department.

percentages and to present the mean  $\pm$  standard deviation (SD) of the continuous variables. Comparison of the percentages of all categorical variables according to the two groups of the cord injuries (none vs SCI and/or VCI) was done by using Pearson's chi-square test. Due to the non-normal distribution, we used the Mann-Whitney test instead of Student's t-test to compare the means of the continuous variables. More than 5% of the

variables (ethnicity, whether patient used alcohol, whether patient used drug, the patient's primary method of payment) were categorized as being not known/not recorded, and as a result we performed multiple imputation procedures to account for these missing data and thus to provide accurate estimates.

We conducted a multivariate logistic regression using a backward selection procedure to determine the predictors of SCI/VCI in patients with firearm-related injury. A receiving operating characteristic (ROC) curve was plotted to assess the validity of the logistic regression results. It indicated that the generated model discriminated excellently patients with no SCI or VCI from those with SCI and/or VCI (area under the ROC curve = 0.9, 95% confidence interval (CI), 0.88 – 0.89,  $P < 0.001$ ). Statistical significance was considered at an alpha value set at 0.05 and below. We performed analyses using the SPSS 24 (IBM Corporation, Armonk, NY) statistical package.

## RESULTS

### Characteristics of Study Subjects

#### *Population and Hospital Characteristics (Table 1)*

A total of 34,898 patients who sustained a firearm-induced injury were included in the analysis. Among those, 2768 patients (7.9%) had SCI or VCI. The mean age of patients with firearm-induced SCI and/or VCI was 30.1 ( $\pm 11.5$  years), and 90.4% ( $N = 2501$ ) were males.

### Main Results

#### *Firearm Injury Characteristics and Locations (Table 2 and Table 3)*

Firearm injuries associated with SCI and/or VCI were more likely to occur in public buildings, streets, and recreation areas (44.1% vs 38.5%;  $P$ -value  $< 0.001$ ). Assault (vs self-inflicted and unintentional injuries) was significantly higher in the SCI and/or VCI (86.4% vs 71.5%;  $P$ -value  $< 0.001$ ). Patients with SCI and/or VCI had more torso injuries (79.8% vs 44%;  $P$ -value  $< 0.001$ ); more head and neck injuries (28.1% vs 23.9%;  $P$ -value  $< 0.001$ ); and fewer injuries to the extremities (40.6% vs 60.1%;  $P$ -value  $< 0.001$ ); and fewer open wounds (52.5% vs 63.2%;  $P$ -value  $< 0.001$ ). Patients with SCI and/or VCI also commonly sustained more fractures (97.1% vs 53.0%;  $P$ -value  $< 0.001$ ), internal organ injuries (75.9% vs 35.6%;  $P$ -value  $< 0.001$ ), and blood vessel injuries (24.9% vs 12.2%;  $P$ -value  $< 0.001$ ). Patients with SCI and/or VCI more commonly had lower GCS score categories (severe [ $\leq 8$ ] 22.7% vs 18.2%;  $P$ -value  $< 0.001$ ) and moderate [9–12] 4.5% vs 2.1%;  $P$ -value  $< 0.001$ ); lower systolic blood pressure (SBP  $\leq 90$  millimeters mercury) (20.0% vs 12.7%;  $P$ -value  $< 0.001$ ); and higher Injury Severity Score (ISS) ( $\geq 16$ ) (63.7% vs 26.0%;  $P$ -value  $< 0.001$ ).

#### *Firearm Injury Outcomes (Table 3)*

The mean length of hospital stay was significantly higher for patients with SCI and/or VCI ( $13.8 \pm 17.3$  days) compared to those with none ( $5.6 \pm 9.4$  days) ( $P$ -value  $< 0.001$ ). On the

other hand, mortality rate in the ED or in hospital was not significantly different between the two groups (14.7%,  $N = 407$  in SCI and/or VCI vs 15.0%,  $N = 4811$  in no SCI or VCI group) ( $P$ -value = 0.703).

#### *Predictors of SCI/VCI in Patients with Firearm-induced Injuries (Table 4)*

**General Predictors:** After adjusting for important confounders, significant positive general predictors of presence of SCI and/or VCI included the following: assault injuries (odds ratio [OR] = 1.44; 95% CI, 1.17 – 1.79; Ref: Unintentional injuries); university hospital (OR = 1.16; 95% CI, 1.05 – 1.30; Ref: community hospital); public buildings, streets, or recreation sites as well as unspecified locations of injury (OR = 1.21; 95% CI, 1.07 – 1.36; Ref: home and residential institution); drug use (OR = 1.35; 95% CI, 1.22 – 1.49; Ref: No drug use); Medicaid coverage (OR = 1.19; 95% CI, 1.06 – 1.34; Ref: self-pay); and air medical transport (OR = 1.22; 95% CI, 1.06 – 1.41; Ref: ground ambulance). Increasing age was a slightly negative predictor for presence of SCI and/or VCI (OR = 0.995, 95% CI, 0.991 – 0.999).

**Clinical Predictors:** Additionally, the following positive clinical predictors were found to be significant for firearm-induced SCI and/or VCI: blood vessel injury (OR = 1.81; 95% CI, 1.60 – 2.05; Ref: no blood vessels injury); fractures (OR = 43.72; 95% CI, 33.94 – 56.32; Ref: no fractures); internal organ injury (OR = 1.38; 95% CI, 1.20 – 1.59; Ref: no internal organ injury); torso injury (OR = 3.25; 95% CI, 2.83 – 3.72; Ref: no torso injury); open wounds (OR = 1.19; 95% CI, 1.07 – 1.32; Ref: no open wounds); a mild or moderate GCS score (OR = 1.36; 95% CI, 1.19 – 1.55 and OR = 1.39; 95% CI, 1.06 – 1.81, respectively; Ref: severe GCS score [ $\leq 8$ ]); and an ISS  $\geq 16$  (OR = 2.25; 95% CI, 2.00 – 2.53; Ref: ISS [ $< 16$ ]). Injury to extremities was a negative clinical predictor (OR = 0.32; 95% CI, 0.29 – 0.36; Ref: no extremity injury).

## DISCUSSION

This retrospective cohort study of 2768 patients who sustained a firearm-induced injury to the spinal cord or vertebral column is the largest to date to report on such injuries. With the exception of a study conducted by Jain et al on traumatic spinal cord injuries in general in the US,<sup>8</sup> most studies were limited to small sample sizes and to single centers. Firearm-induced SCIs are relatively uncommon. The rate of SCI and/or VCI in firearm injuries in the current study was found to be 7.9%. This rate of SCI and/or VCI is lower than the previously reported rates of 10%<sup>12</sup> and 23%<sup>15</sup> among the civilian population, and the 11.10%<sup>16</sup> rate of combat firearm injuries in the military population. The difference in rates across different studies is probably related to civilian vs military setting characteristics and firearms types.

While the mortality rate was not different among patients with SCI or VCI compared to those without, patients with firearm-induced SCI and/or VCI had more severe injuries than

**Table 1.** Demographics of the general study population and the two groups: patients with no spinal cord injury (SCI) or vertebral column injury (VCI), and patients with SCI and/or VCI.

	General population (N = 34,898)	No SCI or VCI (N = 32,130)**	SCI and/or VCI (N = 2,768)	P-value†
Age (years)	31.9 ± 13.5	32.1 ± 13.7	30.1 ± 11.5	<0.001*
Gender				
Female	3,867 (11.1%)	3,601 (11.2%)	266 (9.6%)	0.010
Male	31,022 (88.9%)	28,521 (88.8%)	2,501(90.4%)	
Not known/Not recorded	9 (0.0%)			
Race				
White	11,379 (32.6%)	10,704 (34.4%)	675 (25.2%)	<0.001
Black	18,686 (53.5%)	17,016 (54.6%)	1,670 (62.3%)	<0.001
Other race†	3,771(10.8%)	3,437 (11.0%)	334 (12.5%)	0.023
Not known/Not recorded	1,062 (3.0%)			
Hospital Teaching Status				
Community	11,127 (31.9%)	10,373 (32.3%)	754 (27.2 %)	<0.001
Non-teaching	3,327 (9.5%)	3,148 (9.8%)	179 (6.5 %)	<0.001
University	20,444 (58.6%)	18,609 (57.9%)	1,835 (66.3 %)	<0.001
State Designation				
Not applicable	3,039 (8.7%)	2,827 (8.8%)	212 (7.7%)	0.041
I	21,215 (60.8%)	19,334 (60.2%)	1,881 (68.0%)	<0.001
II	8,430 (24.2%)	7,857 (24.5%)	573 (20.7%)	<0.001
III	2,058 (5.9%)	1,965 (6.1%)	93 (3.4%)	<0.001
IV	65 (0.2%)	61 (0.2%)	4 (0.1%)	0.595
Other	91 (0.3%)	86 (0.3%)	5 (0.2%)	0.389
Hospital Geographic Region				
Northeast	4,537 (13.0%)	4,138 (13.0%)	399 (14.5%)	0.021
Midwest	6,837 (19.6%)	6,333 (19.8%)	504 (18.3%)	0.056
South	17,234 (49.4%)	15,877 (49.7%)	1,357 (49.3%)	0.700
West	6,095 (17.5%)	5,603 (17.5%)	492 (17.9%)	0.651
Missing	195 (0.6%)			
Patient's Primary Method of Payment				
Self-Pay	11,927 (34.2%)	11,057 (34.4%)	870 (31.4%)	0.002
Medicaid	10,361 (29.7%)	9,352 (29.1%)	1,009 (36.5%)	<0.001
Medicare	1,822 (5.2%)	1,733 (5.4%)	89 (3.2%)	<0.001
Private/Commercial insurance	7,880 (22.6%)	7,304 (22.7%)	576 (20.8%)	0.020
Other Government	1,450 (4.2%)	1,353 (4.2%)	97 (3.5%)	0.074
Other and not billed (for any reason)	1,458 (4.2%)	1,331 (4.1%)	127 (4.6%)	0.261
Mode of Transportation				
Ground Ambulance	25,389 (72.8%)	23,288 (73.1%)	2,101 (76.2%)	<0.001
Air Medical Transport	3,864 (11.1%)	3,485 (10.9%)	379 (13.7%)	<0.001
Police	487 (1.4%)	436 (1.4%)	51 (1.8%)	0.040
Public/Private vehicle walk-in	4,474 (12.8%)	4,282 (13.4%)	192 (7.0%)	<0.001
Other	399 (1.1%)	365 (1.1%)	34 (1.2%)	0.680
Not known/not recorded	285 (0.8%)			

\*The Mann-Whitney test was used to calculate the P-value.

\*\*Missing values were disregarded when calculating percentages.

†“Other” race includes Asian, American Indian, Native Hawaiian, or other Pacific Islander and other race.

‡P-values are comparing the “no SCI or VCI” group to the “SCI and/or VCI” group.

**Table 2.** Firearm injury characteristics and locations of the general study population and the two groups: patients with no spinal cord injury (SCI) or vertebral column injury (VCI) and patients with SCI and/or VCI.

	General population (N = 34,898)	No SCI or VCI (N = 32,130)	SCI and/or VCI (N = 2,768)*	P-value
Injury intentionality as defined by the CDC Injury Intentionality Matrix				
Assault	25,348 (72.6%)	22,957 (71.5%)	2,391 (86.4%)	<0.001
Self-inflicted	3,766 (10.8%)	3,671 (11.4%)	95 (3.4%)	<0.001
Unintentional	4,050 (11.6%)	3,905 (12.2%)	145 (5.2%)	<0.001
Other and undetermined	1,734 (5.0%)	1,597 (5.0%)	137 (4.9%)	0.961
Location where injury occurred				
Home and residential institution	11,656 (33.4%)	10,936 (35.3%)	720 (27.1%)	<0.001
Industry, farm and mine	185 (0.5%)	171 (0.6%)	14 (0.5%)	0.870
Public building, street and recreation	13,116 (37.6%)	11,944 (38.5%)	1,172 (44.1%)	<0.001
Unspecified and other	8,691 (24.9%)	7,942 (25.6%)	749 (28.2%)	0.003
Not known/not recorded	1,250 (3.6%)			
Comorbidity				
No	16,728 (47.9%)	15,424 (48.0%)	1,304 (47.1 %)	0.036
Yes	18,170 (52.1%)	16,706 (52.0%)	1,464 (52.9 %)	
Alcohol use				
No	27,087 (77.6%)	24,978 (77.7%)	2,109 (76.2%)	0.061
Yes	7,811 (22.4%)	7,152 (22.3%)	659 (23.8%)	
Drug use				
No	25,710 (73.7%)	23,918 (74.4%)	1,792 (64.7%)	<0.001
Yes	9,188 (26.3%)	8,212 (25.6%)	976 (35.3%)	
Nature of injury as defined by the Barell Injury Diagnosis Matrix				
Blood vessels	4,597 (13.2%)	3,909 (12.2%)	688 (24.9%)	<0.001
Fractures	19,726 (56.5%)	17,037 (53.0%)	2,689 (97.1%)	<0.001
Internal organ	13,533 (38.8%)	11,432 (35.6%)	2,101 (75.9%)	<0.001
Open wounds	21,749 (62.3%)	20,297 (63.2%)	1,452 (52.5%)	<0.001
Others	3,902 (11.2%)	3,486 (10.8%)	416 (15.0%)	<0.001
Region 1: ICD-9 body region as defined by the Barell Injury Diagnosis Matrix				
Extremities	20,438 (58.6%)	19,315 (60.1%)	1,123 (40.6%)	<0.001
Head and neck	8,458 (24.2%)	7,681 (23.9%)	777 (28.1%)	<0.001
Spine and back	2,768 (7.9%)	0 (0%)	2,768 (100%)	<0.001
Torso	16,347 (46.8%)	14,138 (44.0%)	2,209 (79.8%)	<0.001
Unclassifiable by site	2,280 (6.5%)	2,016 (6.3%)	264 (9.5%)	<0.001
GCS Total (ED)				
Severe ( $\leq 8$ )	6,322 (18.1%)	5,708 (18.2%)	614 (22.7%)	<0.001
Moderate (9 – 12)	776 (2.2%)	655 (2.1%)	121 (4.5%)	<0.001
Mild (13 – 15)	26,994 (77.4%)	25,025 (79.7%)	1,969 (72.8%)	<0.001
Not known/not recorded	806 (2.3%)			
SBP (ED)				
$\leq 90$	4,520 (13.0%)	3,981 (12.7%)	539 (20.0%)	<0.001

\*Missing values were disregarded when calculating percentages.

ICD-9, International Classification of Diseases, Ninth Edition; CDC, US Centers for Disease Control and Prevention; GCS, Glasgow Coma Scale Score; ED, emergency department; SBP, systolic blood pressure.

Table 2. Continued.

	General population (N = 34,898)	No SCI or VCI (N = 32,130)	SCI and/or VCI (N = 2,768)	P-value
≥ 91	29,427 (84.3%)	27,275 (87.3%)	2,152 (80.0%)	
Not known/not recorded	951 (2.7%)			
ISS				
< 16	24,245 (69.5%)	23,266 (74.0%)	979 (36.3%)	<0.001
≥ 16	9,877 (28.3%)	8,162 (26.0%)	1,715 (63.7%)	
Not Known/not recorded	776 (2.2%)			

\*Missing values were disregarded when calculating percentages.

SCI, spinal cord injury; VCI, vertebral column injury; ISS, Injury Severity Score.

those without SCI or VCI. They more frequently had higher ISS, lower GCS scores, and lower SBP. These findings further reiterate the high impact of spinal injuries on affected victims in terms of clinical outcomes. However, this analysis may have missed patients with severe injuries or those who died from other major injuries, as they may not have survived long enough for evaluation for SCI and/or VCI.

Patients with SCI and/or VCI were more commonly found to have concomitant fractures, internal organ injuries, and blood vessel injuries compared to patients with no SCI or VCI. Furthermore, the injury location among patients with SCI and/or VCI involved the torso and head and neck more commonly than those with no SCI and/or VCI injury. These findings are in line with those of a previous study that examined patients who presented with gunshot wounds to the trunk, neck, or head over a 10-year period to a trauma center in Miami, Florida, where concomitant spine injuries were found in 10% of cases. It is worth noting that in the latter study, 13% of the detected cases of spine injuries were unsuspected, particularly when they involved the face (75%), abdomen (27%), chest (10%), shoulder (10%), back (5%), and flank (5%), but not the head.<sup>12</sup>

The mean length of hospital stay of 13.8 days ( $\pm$  17.3) is slightly higher than the mean of 11 days reported by the National Spinal Cord Injury Statistical Center. Rehabilitation duration is not reported in the NTDB, but the national average rehabilitation length of stay is estimated to be around 31 days.<sup>10</sup> The intensive care unit stay and ventilator days in the current study were also found to be significantly higher for patients with SCI and/or VCI compared to none. This translates into high healthcare costs secondary to firearm-induced SCI and/or VCI. According to the National Spinal Cord Injury Statistical Center, the average yearly expenses of affected individuals vary between US dollars \$44,766 – \$1,129,302, depending on the degree of neurological impairment, level of education, and pre-injury employment history.<sup>10</sup> This is important in estimating the potential impact of the high cost of care of these injuries on patients and the government, especially given that a large portion of the study population is covered by Medicaid. Mitigation strategies, such as the adoption and enforcement of strict gun control laws, are needed to prevent such injuries and reduce their financial burden on affected victims.

Table 3. Outcomes of the general study population and the two groups: patients with no spinal cord injury (SCI) or vertebral column injury (VCI) and patients with SCI and/or VCI.

	General population (N)	General population (Mean $\pm$ SD)	No SCI or VCI (N = 32,130)	SCI and/or VCI (N = 2,768)	P-value
Died in ED/hospital					
No	28,887 (82.8%)		26,608 (82.8%)	2,279 (82.3%)	0.521
Yes	5,218 (15.0%)		4,811 (15.0%)	407 (14.7%)	0.703
Not known/not recorded	793 (2.3%)				
Total length of stay in days	34,850	6.3 $\pm$ 10.45	5.6 $\pm$ 9.4	13.8 $\pm$ 17.3	<0.001*
Total number of days spent in the intensive care unit	11,883	6.0 $\pm$ 8.5	5.5 $\pm$ 7.7	9.0 $\pm$ 11.9	<0.001*
Total number of days spent on a ventilator	8,427	4.9 $\pm$ 7.8	4.3 $\pm$ 6.4	7.8 $\pm$ 12.7	<0.001*

\*The Mann-Whitney test was used to calculate the P-values.

SCI, spinal cord injury; VCI, vertebral column injury; ED, emergency department; SD, standard deviation.

**Table 4.** Predictors of spinal cord injury/vertebral column injury in patients with firearm-induced injury.

	Odds ratio	95% CI	P-value
General predictors			
Age*	1	0.99-1.00	0.027
Hospital teaching status (community)			
Non-teaching	0.84	0.69 – 1.03	0.085
University	1.16	1.05 – 1.30	0.006
Injury Intentionality as defined by the CDC Injury Intentionality Matrix (Unintentional)			
Self-inflicted	0.31	0.23 – 0.42	<0.001
Assault	1.44	1.17 – 1.79	0.001
Other and undetermined	1.25	0.93 – 1.68	0.144
Location where injury occurred (Home & residential institution)			
Industry, farm and mine	1.15	0.58 – 2.27	0.698
Public building, street and recreation	1.21	1.07 – 1.36	0.002
Unspecified and other	1.2	1.05 – 1.37	0.008
Drug use			
Yes	1.35	1.22 – 1.49	<0.001
The patient's primary method of payment (self-pay)			
Medicaid	1.19	1.06 – 1.34	0.004
Medicare	1.07	0.81 – 1.42	0.628
Private/commercial insurance	1.06	0.92 – 1.21	0.412
Other government	0.82	0.62 – 1.07	0.146
Other and not billed (for any reason)	1.1	0.87 – 1.39	0.441
Mode of transportation (Ground Ambulance)			
Air Medical Transport	1.22	1.06 – 1.41	0.007
Police	0.61	0.41 – 0.90	0.013
Public/private vehicle walk-in	0.71	0.59 – 0.86	<0.001
Other	0.94	0.62 – 1.44	0.782
Clinical predictors			
Nature of injury as defined by the Barell Injury Diagnosis Matrix (Reference: No)			
Blood vessel injury	1.81	1.60 – 2.05	<0.001
Fractures	43.72	33.94 – 56.32	<0.001
Internal organ injury	1.38	1.20 – 1.59	<0.001
Open wounds	1.19	1.07 – 1.32	0.001
Extremities injury	0.32	0.29 – 0.36	<0.001
Torso injury	3.25	2.83 – 3.72	<0.001
GCS total (ED) (Severe ( $\leq 8$ ))			
Moderate (9 – 12)	1.39	1.06 – 1.81	0.016
Mild (13 – 15)	1.36	1.19 – 1.55	<0.001
ISS ( $\leq 15$ )			
$\geq 16$	2.25	2.00 – 2.53	<0.001

\*Rounded up: 3-decimal odds ratio for age = 0.995; 95% confidence interval [0.991 – 0.999.]

CI, confidence interval; GCS, Glasgow Coma Scale Score; ED, emergency department; SBP, systolic blood pressure; ISS, Injury Severity Score.

This study is the first to identify predictors of firearm-induced SCI and/or VCI. A previous study examined prehospital predictors of traumatic spinal cord injuries in general: male

gender; neurological deficit; altered mental status; high falls; diving injuries; and bike/motorbike collisions.<sup>17</sup> Main predictors for firearm-induced SCI and/or VCI included unintentional

injuries, assault forms of injuries, public or unspecified location of injuries, concomitant drug use by the subject, injury of the torso, as well as concomitant fractures, injuries to blood vessels, internal organs, or open wounds. Familiarity with these predictors is important for emergency providers, which would translate into earlier detection and management of SCI and/or VCI injuries and ultimately improved patient outcomes. Nevertheless, the full clinical utilization of such predictors, among others, would require further studies and the development and verification of clinical prediction rules.

## LIMITATIONS

This study did have a number of limitations. While the NTDB cohort is the largest registry representative of US-based trauma, some data elements that better characterize firearm-induced SCI and/or VCI (such as types of firearms, interval neurological examinations, and neurological outcomes at discharge) are not collected or reported. For instance, low GCS may be related to different factors and not limited to traumatic brain injury, which is not specified in the NTDB. While missing data is also considered a limitation of this study, the latter was addressed in the analysis via multiple imputations. Despite these limitations, the findings of this study, which used the NTDB dataset, apply in hospitals and trauma centers across the US and in similar clinical settings.

## CONCLUSION

Firearm-induced spinal cord and/or vertebral column injuries have a high burden on affected victims. This study identifies important general and clinical predictors for the presence of these injuries in trauma patients with firearm injuries. These predictors can help physicians suspect and detect the presence of SCI and/or VCI injuries for earlier management in order to improve outcomes of affected patients. Future studies involving databases with more detailed, neurological clinical data points can help further define the impact of such injuries on affected victims.

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*Address for Correspondence:* Mazen J. El Sayed, MD, MPH, American University of Beirut Medical Center Department of Emergency Medicine, P.O. Box 110-0236 Riad El Solh, Beirut, Lebanon, 1107 2020. Email: melsayed@aub.edu.lb.

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# Assessing Violence Risk in Adolescents in the Pediatric Emergency Department: Systematic Review and Clinical Guidance

Megan M. Mroczkowski, MD\*

John T. Walkup, MD†

Paul S. Appelbaum, MD\*

\*Columbia University Irving Medical Center, Department of Psychiatry, New York, New York

†Ann & Robert H. Lurie Children's Hospital of Northwestern University, Department of Psychiatry and Behavioral Sciences, Chicago, Illinois

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**Introduction:** Violence risk assessment is one of the most frequent reasons for child and adolescent psychiatry consultation with adolescents in the pediatric emergency department (ED). Here we provide a systematic review of risk factors for violence in adolescents using the risk factor categories from the MacArthur Violence Risk Assessment study. Further, we provide clinical guidance for assessing adolescent violence risk in the pediatric ED.

**Methods:** For this systematic review, we used the preferred reporting items for systematic reviews and meta-analyses (PRISMA) 2009 checklist. We searched PubMed and PsycINFO databases (1966–July 1, 2020) for studies that reported risk factors for violence in adolescents.

**Results:** Risk factors for adolescent violence can be organized by MacArthur risk factor categories. Personal characteristics include male gender, younger age, no religious affiliation, lower IQ, and Black, Hispanic, or multiracial race. Historical characteristics include a younger age at first offense, higher number of previous criminal offenses, criminal history in one parent, physical abuse, experiencing poor child-rearing, and low parental education level. Among contextual characteristics, high peer delinquency or violent peer- group membership, low grade point average and poor academic performance, low connectedness to school, truancy, and school failure, along with victimization, are risk factors. Also, firearm access is a risk factor for violence in children and adolescents. Clinical characteristics include substance use, depressive mood, attention deficit hyperactivity disorder, antisocial traits, callous/unemotional traits, grandiosity, and justification of violence.

**Conclusion:** Using MacArthur risk factor categories as organizing principles, this systematic review recommends the Structured Assessment of Violence Risk in Youth (SAVRY) risk- assessment tool for assessing adolescent violence risk in the pediatric ED. [West J Emerg Med. 2021;22(4.1):37–46.]

## BACKGROUND

Violence or aggression among adolescents is a common problem of enormous public health significance. Physical fighting is the most common form of violence in adolescents.<sup>1</sup> In addition to the increased risk for injury and substance abuse, those who fight report less satisfaction with life, poorer relations with family and peers, and a worse perception of school. Within the past 12 months, 32.8% of high school-

aged youth have been in a fight and 16.6% carried weapons to school.<sup>2</sup> Since the 1980s, youths aged 10-17 years constituted less than 12% of the US population but have been offenders in 25% of serious violent victimizations.<sup>3</sup>

The evolution of violence can be conceptualized to begin in young childhood. Children first learn to manage aggression from their parents as toddlers; poor parenting, such as abuse, neglect, coercive parenting styles, antisocial modeling, and

poor limit setting, may lead to an increased risk for violence.<sup>4</sup> About 30% of those with oppositional defiant disorder go on to develop conduct disorder.<sup>5</sup> Of those with conduct disorder, about 40% will progress to antisocial personality disorder.<sup>6</sup>

There are two main patterns of development of violence: early onset and late onset.<sup>7</sup> Early-onset violence begins before puberty, accounts for 30% (+/- 15%) of serious violent offenders,—13% of whom go on to violent careers longer than two years—and is strongly associated with general offenses and substance use.<sup>7</sup> In contrast, late-onset violence begins after puberty and accounts for 70% (+/- 15%) of serious violent offenders, 2% of whom go on to violent careers longer than two years.<sup>7</sup> Late-onset violence is associated with weak social ties, antisocial and delinquent peers, and gang membership.<sup>7</sup>

There are key differences between violent behavior in adolescents and adults.<sup>7</sup> These differences can be categorized into epidemiology, diagnoses, behavior patterns, treatment, and legal status. In adolescents, compared to adults, violence is much more common and accounts for a higher proportion of all deaths, and violent careers are shorter; the first episode of serious violence most often occurs in adolescence, sometimes childhood, and rarely in adulthood.<sup>7</sup> Psychotic disorder is much less common in adolescents who are violent than in adults. Adolescent violent behaviors tend to occur more in groups than adult violent behavior.<sup>7</sup>

Programs at all levels of schooling are effective in preventing violence. In addition to reducing aggressive and violent behaviors, these programs also improve school achievement and activity levels, and reduce truancy.<sup>8</sup> In middle school, programs focus on disruptive behaviors, bullying, and general violence, while high school programs focus on violence, dating violence, and bullying. The programs that decreased violence most drastically were those taught by peers.<sup>8</sup> Treatment for adolescents who are violent should consider both peer and family involvement.<sup>7</sup> Adolescent legal status allows for legal consent for treatment to be provided by a legal guardian and, with some variation by age across states, hospitalization can occur over the patient’s objection with a legal guardian’s consent.<sup>7</sup>

Aggression and violence are one of the most frequent reasons for child psychiatry consultation on adolescents in the emergency department (ED).<sup>9</sup> Assessment of violence risk may be required to determine appropriate disposition and avoid liability for untoward outcomes. Therefore, predicting who may become violent is of utmost importance. Unfortunately, predicting violence can be difficult; studies have shown that psychiatrist and nurse predictions of violence in both inpatient and community samples are poor, at times not differing from chance.<sup>10</sup>

Assessing violence risk falls into the purview of pediatricians and child and adolescent mental health professionals. Following work in adult, actuarial risk-assessment scales, there has been progress in applying scales to adolescents.<sup>11</sup> The two scales that have the strongest

psychometric support are the Structured Assessment of Violence Risk in Youth (SAVRY) and the Psychopathy Checklist-Youth Version (PCL-YV).<sup>12,13</sup> However, neither these nor other scales are routinely used in clinical practice.

To equip both ED pediatricians and child and adolescent mental health professionals with the best knowledge to confront the assessment and treatment of aggression, we report a systematic review of the literature on risk factors for violence in adolescents in the community and characterize what is currently known using the risk factor categories from the MacArthur Violence Risk Assessment study as organizing principles; identify gaps in knowledge; and discuss recommendations for further research.<sup>14</sup> We conclude with recommendations for assessing adolescent violence risk in the pediatric ED.

**METHODS**

**Protocol and Registration**

For this systematic review, we used the preferred reporting items for systematic reviews and meta-analyses (PRISMA) 2009 checklist. Full details of this review are listed below.

**Eligibility criteria and Data Sources**

We searched *PubMed* and *PsycINFO* databases (1966–July 1,2020) for studies that reported risk factors for violence in adolescents. We also searched reference lists from identified reports for additional sources. We considered only articles published in English.

**Search**

To create a comprehensive list of studies examining risk factors for adolescent violence, we used combinations of the following search terms (Figure).

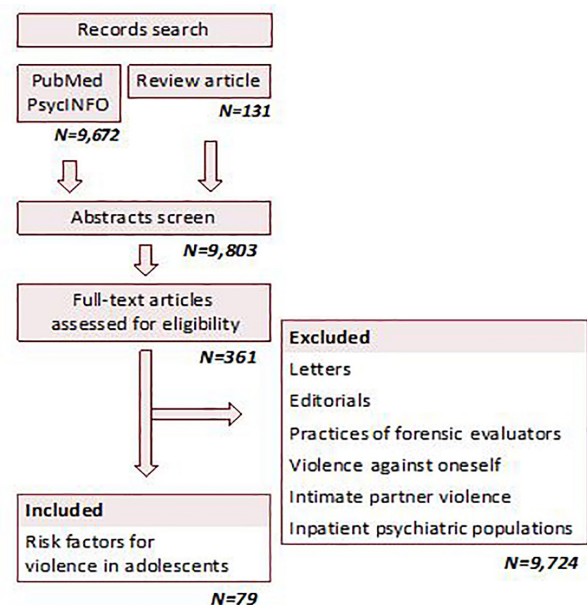


Figure 1. Search terms.

**PubMed database:**

risk factors AND violence AND juveniles (#66); risk factors AND violence AND juveniles AND review (#13); predictors AND violence AND juveniles (#8); predictors AND aggression AND juveniles (#5); predictors AND violence AND adolescents (#1107); risk factors AND violence AND adolescents (#7270).

**PsycINFO database:**

risk factors AND violence AND juveniles (#63), risk factors AND violence AND juveniles AND review (#13), predictors AND violence AND juveniles (#17), predictors AND aggression AND juveniles (#10), predictors AND violence AND adolescents (#297); risk factors AND violence AND adolescents (#803).

**Study Selection**

We included a study in our dataset if it examined or included risk factors for violence in adolescents. We defined adolescent as an individual between the ages of 11-18. Violence was defined as fighting, using a weapon in a fight, hitting or beating up someone, hurting someone badly enough to need bandages or a doctor, or using a weapon to obtain something. Violence did not include violence against oneself.

We excluded a study from the dataset if it had any of the following characteristics: 1) only included violence among inpatient populations; 2) focused solely on intimate partner violence; 3) was a review, letter or editorial; 4) had been withdrawn; or 5) only described clinical violence assessment practices of forensic evaluators. The lead investigator (MM) searched and vetted each prospective paper, sharing the descriptive information with co-authors (JW and PA) for their review and comments. The lead investigator, taking these comments, had the final say on study inclusion.

**Data Collection Process**

We extracted data and recorded information on the details of where and how the study was conducted, sample characteristics, size of study, and how risk factors were measured.

**Data Items**

We categorized the correlates of violence identified in the studies using the typology of the MacArthur risk assessment study: *Personal, Historical, Contextual and Clinical* characteristics.<sup>14</sup> A risk factor was considered positive if there was a statistically significant ( $P < 0.05$ ) association with violence as an outcome. The number of total subjects in each row (N) in Tables 1-4 indicates the number of subjects in studies in which the results for that variable were significant.

**Risk of Bias in Individual Studies and Across Studies**

We considered potential biases at the study level, broadly defined, focusing on flawed study design. Given that in this

systematic review we considered studies with multiple outcome measures that differed across studies, standard metrics of bias in the literature (eg, publication bias) were inapplicable.

**RESULTS****Study Characteristics**

All but two of the studies in this review were surveys or longitudinal observational studies. There were no randomized controlled trials addressing violence risk in adolescents.

**Risk of Bias Within Studies**

Many of the studies suffered from flaws in study design. Taken as a whole, the studies considered a constricted range of risk factors, weak criterion measures of violence, narrow study samples, and data gathered at a single site. These flaws are elaborated on in the Discussion section.

**Results of Individual Studies**

*Personal characteristics* (Table 1) found to be correlates for violence in adolescents included male *gender*, *race* (Black, Hispanic, or multiracial), *religion* (no religious affiliation), *IQ* (lower IQ), and *age* (younger age).<sup>15-28</sup>

**Table 1.** Personal risk factors found to be correlates for violence in adolescents.

Risk factor	N (total)	References
Gender		
Male gender	33,902	15,16-19,20-24
Religion		
No religious affiliation	3,872	20
Race		
Black	3,107	16,22
Hispanic	84,734	25
Multiracial	2,305	28
IQ		
Lower IQ	588	26,27
Age		
Younger age	2,385	19

IQ, intelligence quotient.

*Historical characteristics* (Table 2) can be further organized within the following subcategories: *criminal history*, *disruptive behavior*, *parental criminal history*, *physical abuse*, and *family history*. Within the subcategory of *criminal history*, a younger age at first offense, higher number of previous criminal offenses, prior violence, and drug selling were found to be correlates for violence in children and adolescents. *Disruptive behavior* can be characterized by aggressiveness or fighting in childhood, cruelty to people, early antisocial

**Table 2.** Historical risk factors.

Risk factor	N (total)	References
<b>Criminal history</b>		
Younger age at first offense	11,008	15,29-33
Prior violence	24,784	55-57,21,47,58
Drug selling	4,586	21
Arrests	3,818	55
<b>Disruptive behavior</b>		
Cruel to people	1,517	30
Childhood aggressiveness (boys)	415	54
Children characterized as under-controlled at age 6	731	53
Childhood fighting	808	16
Early antisocial influences	808	16
Conduct problems	11,580	27,36,50-52
Carrying weapon	29,520	47,49
Animal cruelty	542	23
<b>Parental criminal history</b>		
Parental or familial criminality	8,012	29,27
<b>Physical abuse</b>		
Physical abuse	172,957	38,40-48
Sexual abuse	140,021	38,39
Neglect	1,037	39
Witnessing abuse	136,549	38
<b>Family history</b>		
Poor child-rearing of parent	411	27
Low parental education level	5,385	35-37
Parental job loss	4,586	21
Higher maternal antisocial personality disorder score	2,562	19,26
Maternal bipolar disorder and perpetrating intraparental violence	120	34
Family alcohol or drug use	139,386	38,71
Low parental support	29,565	20,21,61
Parent convicted of crime	411	27

influences or behaviors, conduct problems, under-controlled behavior at age six, carrying a weapon, and animal cruelty. *Parental criminal history* involves criminal history in either parent. *Physical abuse* is described as maltreatment starting in childhood or adolescence. *Family history* risk factors include the child's parents experiencing poor child-rearing when they were children, low parental education level, and higher maternal antisocial personality disorder score, maternal

bipolar disorder, interparental violence, family alcohol or drug use, and low parental support.<sup>15,16,19,21,23,26,27,29-58</sup>

*Contextual characteristics* (Table 3) found to be correlates for violence in adolescents include the categories of *school*, *social relations*, *firearm access*, *relationship with parents*, and *socioeconomic status*. Within the category of *school*, low connectedness or support at school, low grade point average, truancy, low school motivation, suspensions, feeling unsafe at school, poor study skills, school failure or repeating a grade, wanting to quit school, or feeling school discipline is unfair are all risk factors. *Social relations* that were risk factors included high peer delinquency, friends who use drugs, bullying others, victim of bullying, gang affiliation, sexually active, unsafe sex (in males), fewer friends committed to learning, dating violence, belonging to a sports team, peer pressure, and low peer support. *Firearm access* is a risk factor for violence in children and adolescents.<sup>59</sup> Risk factors within the category *relationship with parents* include family strain, high parental stress, parental psychological aggression, parental non-authoritative behavior, poor relationship with parents, parent-child conflict, less parental control, rejecting parenting, and living in a single-parent household. *Socioeconomic status* risk factors include low socioeconomic status, exposure to community violence, drug use in the community, community disorganization, having five or more siblings, and living in a neighborhood where young people are in trouble.<sup>17-19,22,24,27,30-32,35-37,45-47,49-52,55,57,59-80</sup>

*Clinical characteristics* (Table 4) associated with correlates for violence in adolescents were organized into the following categories: *substance use*; *depressive symptoms*; *attention deficit hyperactivity disorder (ADHD)*; *impulse control*; *temperament and personality trait*; and *psychopathy*. Cigarette, alcohol, and other illicit substances were found to be risk factors and can be classified under *substance use*. Symptoms related to *depression*, including suicide attempts, are risk factors for violence, as are *ADHD*, post-traumatic stress disorder, and *psychotic-like experiences*. *Impulse control* deficits, including lack of self-control, risk-taking behaviors, and previous unintentional injury, were also associated with violence risk. *Temperament and personality traits* that were risk factors include antisocial traits, callous/unemotional traits, grandiosity, justification of violence, intrapersonal strain, anger, perceived invulnerability to future events and the belief that damaging another's property while intoxicated was acceptable, Cluster A and B personality traits, emotional distress, higher levels of aggressive beliefs, poor emotion regulation, and reduced likelihood of suppressing anger were also risk factors for violence.<sup>15,16,19-22,24,27,30,32,35-37,42,45,47,49,51,52,56,57,60,62-66,68,69,71,75,81-90</sup>

## DISCUSSION

### Summary of Evidence

From the studies included in our dataset, several risk factors were found in multiple studies and stand out

**Table 3.** Contextual risk factors.

Risk factor	N (total)	References
<b>School</b>		
Low connectedness/support at school	23,886	32,60,62
Low GPA	18,613	27,46,50,60,63, 64
Truancy	14,627	30,47
Low school motivation	1,517	30
Suspensions	12,703	55,63
Feel unsafe to go to school	46,756	49,65
Poor study skills	4,432	66
School failure/repeat grade	27,302	27,47,67
Wanting to quit school	3,955	51
Felt school discipline unfair	282	62
<b>Social relations</b>		
High peer delinquency	29,902	30,31,55,57,68-70,18,19,31,64, 66,71,72
Friends who use drugs	3,174	31,71
Bullying others	20,054	36,73,74
Victim of bullying or violence	21,789	24,71,75
Gang affiliation	1,642	46
Sexually active	2,299	22
Fewer friends committed to learning	2,055	31
Dating violence	1,080	31
Belonging to a sports team	1,642	46
Low peer support/peer rejection	28,898	61,70,72
Practicing unsafe sex (males only)	7,548	45
Peer pressure	4,056	70
Access to firearms	12,734	59,76
<b>Relationship with parents</b>		
Family strain	848	75
Parental psychological aggression	302	68
High parental stress	1,517	30
Parental non-authoritative behavior	2,335	35
Poor relationship with parents	9,603	31,45
Parent-child conflict	12,417	32,55,70,72
Less family involvement	1,080	31
Less parental control	1,080	31

GPA, grade point average.

**Table 3. Continued.**

Risk factor	N (total)	References
Living in single-parent household	10,261	36,45
Rejecting parenting	310	52
<b>Socioeconomic status</b>		
Low socioeconomic status	49,113	27,30,61,77
Exposure to community violence	3,176	17,18,31,76,78-80
Drug use in neighborhood	4,626	55,64
Community disorganization	3,818	55
5+ siblings	511	27
Neighborhoods where young people were in trouble	808	32

clearly. Personal risk factors include male gender and race (Black, Hispanic or multi-racial), along with lower IQ and younger age. Historical risk factors include childhood aggressiveness in boys, childhood fighting, early antisocial influences, hyperactivity and withdrawal in childhood, child maltreatment, and higher maternal antisocial personality disorder score. Younger age at first offense and prior violence were described in a multitude of studies. These risk factors fit with the adage that “the best predictor of future behavior is past behavior,” in that those children who were aggressive or in fights were at risk for future violent behavior. Moreover, early influences are also apparent within this category; specifically, maltreatment as a child or early antisocial influences, especially by the mother, were risk factors. Children learn from the actions of their early caretakers, even if these are antisocial in nature. Additionally, children and adolescents who were themselves maltreated are at risk for perpetrating violence on others.

**Limitations of the Literature**

The flaws identified in this body of research can be organized and addressed using the critique of violence research on persons with mental illness offered by Monahan and Steadman.<sup>10</sup> They identified four problems: constricted range of risk factors; weak criterion measures of violence; narrow study sample; and data gathered at a single site.

*Restricted range of risk factors*

The first problem is that different studies focus on different risk factors, with no study looking comprehensively at the full range of risk factors. While studies may have included several risk factors, unless they are all measured simultaneously, it is unclear how they interact or whether

**Table 4.** Clinical risk factors.

Risk factor	N (total)	References
<b>Substance use</b>		
Alcohol use	75,287	20,22,24,35,37,42,47,49,63,66,81,82
Illicit drug use	121,891	56,63,69,83-85,19,21,22,24,65,71,84, 86
Cigarette smoking	11,694	20,37,86
<b>Depression</b>		
Depression symptoms	4,491	30,35,37,68
Suicide attempt	16,410	49
PTSD	3	90
ADHD	10,209	16,27,32,36,60,64,66
Psychosis-like experiences	18,104	24
<b>Impulse control</b>		
Lack of self-control	1,100	15,87
Risk-taking behaviors	9,770	27,45,57,75
Previous unintentional injury	337	37
<b>Temperament and personality traits</b>		
Antisocial traits or favorable attitude toward antisocial behavior	7,989	19,51,56,57,68,71
Grandiosity	974	89
Justification of violence	974	89
Anger	5,312	20,69
Callous/unemotional traits	3,019	36,56,69
Perceived invulnerability to future events	2,335	35
Belief that hurting another's property while intoxicated is acceptable	1,332	84
Cluster A and B personality traits	717	88
Emotional distress	1,719	87
Poor emotion regulation	310	52
Higher levels of aggressive beliefs	1,719	87
Less likely to suppress anger	282	62

PTSD, post-traumatic stress disorder; ADHD, attention deficit hyperactivity disorder.

one fully accounts for the variance that would otherwise be associated with the other. This limits the utility of the data for

clinicians, who may be uncertain how much weight to give one or another variable in assessing violence risk.

Risk factors in studies of adolescents have focused on past history and symptom rating scales, such as the Brief Psychiatric Rating Scale. These variables are too narrow and may miss many key risk factors. For instance, risk factors should be studied in multiple domains, including historical and contextual, along with those within a single domain that may be theoretically related, such as impulsivity and anger management. In this review, studies did look at childhood traits such as hyperactivity, conduct problems, and aggressiveness, which may be a good start. Further, various symptoms have been studied, including depressive symptoms and substance abuse. However, it would be more meaningful to document changes in symptoms over time and explore how specific symptom clusters within a broader diagnosis may affect risk. Situational risk factors have been addressed, such as poor academics, truancy, peer delinquency, access to firearms, parental stress and low socioeconomic status, but not consistently across studies.

#### *Weak criterion for violence*

The second problem is weak criterion measures for violence. Typically, violence was defined in an undifferentiated manner, ie, all violent outcomes were treated the same. It may be helpful for researchers to define subtypes of violence, as predictors for one type of violence (eg, impulsive violence) may vary from another type (eg, gang violence). However, studies in our review rarely divided violent outcome by subtypes.

#### *Narrow study samples*

The third problem identified was narrow study samples. A majority of the studies in this review focused on populations of juvenile delinquents, schools in high-crime areas with low socioeconomic status, mental health clinics, and so-called at-risk youth. Broader samples of subjects should be sought. For example, studies should include both genders, those with and without a history of violence, and multiple socioeconomic statuses. Crucial for further research is the need to widen the inclusion criteria such that risk factors can be understood more universally.

#### *Data gathered from single site*

The fourth problem found was data gathered at a single site. When only one site is used, idiosyncratic aspects of the sample available, treatments used, and approaches to rating study variables can limit the generalizability of the data. Studies with larger samples and, therefore, more stable findings usually require research efforts to be coordinated across multiple sites. A few of the studies in this review were national in scope, in the United States and Finland, but the majority were limited to one or a small number of sites. As the research currently stands, groups have created their own lists of predictors and variables, which

has led to disjointed findings in the literature. Ideally, groups of researchers should combine efforts in a multidisciplinary and multisite fashion to create common predictors and variables to study risk factors in large number of adolescents.

### Limitations of the Review

We did not rate the potential bias in individual studies. There were no randomized controlled trials identified in this search. A majority of the studies were surveys or longitudinal observational studies and, therefore, we did not include the study grade in our tables. Furthermore, we included only English-language papers, searching *PubMed* and *PsycINFO*, which may have led to the exclusion of some studies.

### Implications for Clinical Risk Assessment

Clinically, organizing risk factors by MacArthur risk factor categories may be useful as a means to carry out a risk assessment with an adolescent presenting to the ED with violence risk. Risk assessment may include interviews with the subject, caretaker, family member, and teacher, along with reviewing mental health, school and police records.<sup>91</sup> Given the large number of variables that have been associated with violence and likelihood of significant overlap in the variance for which they account, risk assessment tools may be useful, as may tests of psychopathology, intelligence, and psychopathy. In a study of forensic evaluators, the most used of such tests were the Wechsler Intelligence Scales (75%), the Minnesota Multiphasic Personality Inventory (66.2%), and the SAVRY risk-assessment tool (35.1%).<sup>91</sup> Additionally, one third of clinicians surveyed always or almost always used the Psychopathy Checklist: Youth Version (PCL:YV).<sup>91</sup> Each of these tests provides further information for risk assessment and includes a portion of the factors identified in this review.

The SAVRY is the violence risk-assessment instrument for adolescents most commonly used by forensic evaluators.<sup>91</sup> Its rating form is organized into historical risk factors, social/contextual risk factors, individual/clinical risk factors, and protective factors.<sup>12</sup> Historical risk factors include history of violence; early initiation of violence and exposure to violence at home; childhood history of maltreatment; parental/caregiver criminality; and poor school achievement. Social/contextual risk factors include peer delinquency; peer rejection; stress and poor coping; and poor parental management, among others. Individual/clinical risk factors include risk taking/impulsivity; substance use difficulties; anger management problems; attention deficit/hyperactivity difficulties; and low interest/commitment to school, among others. Protective factors include prosocial involvement; strong social support; strong commitment to school; and positive attitude toward intervention and authority.<sup>12</sup>

### Conclusions and Recommendations for Assessing Violence Risk in the Pediatric Emergency Department

Violence in adolescents is a problem with large public health significance. Its risk factors can be organized using the

MacArthur risk assessment study categories. The Structured Assessment of Violence Risk in Youth is the most commonly used violence risk-assessment instrument for adolescents by forensic evaluators.<sup>91</sup> Given this systematic review, we recommend its use in the pediatric ED to assess adolescent violence risk. Its rating form is organized into historical risk factors, social/contextual risk factors, individual/clinical risk factors, and protective factors.<sup>10</sup> Overall, the SAVRY provides a comprehensive means of assessing risk factors as the literature now stands, and likely is best used in combination with clinical interviews and other testing.

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*Address for Correspondence:* Megan M. Mroczkowski, MD, Morgan Stanley Children's Hospital of NewYork-Presbyterian, Columbia University Irving Medical Center, Department of Psychiatry, 3959 Broadway CHN 619C, New York, NY 10032. Email: mmm2323@cumc.columbia.edu.

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# Lethal Means Counseling for Suicidal Adults in the Emergency Department: A Qualitative Study

Bonnie J. Siry, MSSc\*

Christopher E. Knoepke, PhD, MSW<sup>†‡§</sup>

Stephanie M. Ernestus, PhD<sup>¶</sup>

Daniel D. Matlock, MD, MPH<sup>||#</sup>

Marian E. Betz, MD, MPH<sup>\*#</sup>

\*University of Colorado School of Medicine, Department of Emergency Medicine, Aurora, Colorado

<sup>†</sup>University of Colorado School of Medicine, Division of Cardiology, Aurora, Colorado

<sup>‡</sup>University of Colorado School of Medicine, Adult & Child Consortium for Outcomes Research & Delivery Science, Aurora, Colorado

<sup>§</sup>University of Southern California, USC Suzanne Dworak-Peck School of Social Work, Los Angeles, California

<sup>¶</sup>Stonehill College, Department of Psychology, Easton, Massachusetts

<sup>||</sup>University of Colorado School of Medicine, Department of Geriatric Medicine, Aurora, Colorado

<sup>#</sup>VA Eastern Colorado Geriatric Research Education and Clinical Center, Aurora, Colorado

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**Introduction:** Lethal means counseling (to reduce access to firearms or other suicide methods) is a recommended critical yet challenging component of care of suicidal patients. Questions remain about communication strategies for those in acute crisis.

**Methods:** This qualitative study was an analysis of semi-structured interviews with English-speaking, community-dwelling adults with a history of lived-experience of suicidal ideation or attempts in themselves or a family member. We used a mixed inductive and deductive approach to identify descriptive themes related to communication and decision-making.

**Results:** Among 27 participants, 14 (52%) had personal and 23 (85%) had family experience with suicide ideation or attempts. Emergent themes fell into two domains: (1) communication in a state of high emotionality; and (2) specific challenges in communication: initiating, maintaining engagement, considering context.

**Conclusion:** Engaging suicidal individuals in lethal means counseling may be more effective when messaging and approaches consider their emotional state and communication challenges. [West J Emerg Med. 2021;22(4.1):47-53.]

## INTRODUCTION

Emergency departments (ED) are the site where patients with acute suicidal ideation or attempts (SI/SA) are generally sent for immediate evaluation and intervention. There is a spectrum of interventions for patients with SI/SA, from inpatient psychiatric hospitalization to outpatient follow-up. Lethal means counseling (LMC) – counseling meant to reduce access to firearms, medications, and other highly lethal methods is recognized as

an essential, evidence-based component of suicide prevention,<sup>1</sup> especially for patients being discharged home. Prior work has shown that LMC may positively affect home storage behaviors, especially among parents of suicidal adolescents.<sup>2,3</sup>

Yet LMC in the ED does not routinely occur with suicidal adults. Even among those being discharged home, counseling is documented in only about half of these patients.<sup>4</sup> Identified barriers to counseling include unclear provider responsibilities

(e.g., whether ED or behavioral health clinicians should provide counseling<sup>5,6</sup>), lack of protocols or training (for both ED and behavioral health clinicians), and hesitancy about discussing firearms with patients.<sup>7</sup> In response, organizations have called for increased clinician training and engagement in LMC,<sup>8,9</sup> highlighting the need for identifying evidence-based best messages and messengers for this work.<sup>10,11</sup> As an example, “means safety” (vs “means restriction”) was both more acceptable to participants and made participants more willing to consider reducing access to lethal means.<sup>12</sup> Other evidenced-based work underscored the need for engaging the firearms community in developing “culturally specific” messaging, such as drawing on the values of safety, responsible ownership, and protection of loved ones.<sup>13,14</sup>

While efficacy and clinician uptake have been broadly described, there has been less work exploring how individuals with acute SI/SA might perceive LMC. Questions remain about how best to promote behavior change (i.e., to reduce home lethal means access) among individuals with acute suicide risk. This is especially true for adults, where it is the at-risk individual (rather than the non-suicidal parent of an at-risk adolescent) who receives LMC and is responsible for making changes. These adults also have unique needs related to understanding of LMC messaging; individuals with active SI/SA being evaluated in an ED are likely to have altered cognition, reasoning, processing, and emotional expression, suggesting the need for tailored messaging, language, and implementation. As provider engagement in LMC increases, the need for tailored communication also increases – tailoring not only with respect to firearms but also to the cognitive state of a suicidal adult.

### Objective

We sought to use qualitative interviews with people with lived experience of SI/SA to explore challenges and strategies related to LMC and effective communication in acute settings such as EDs.

### Study Sample

Participants were a part of a larger study that created a patient-facing decision aid for reducing lethal means access in the context of suicide risk.<sup>14-16</sup> Participants were recruited through direct email invitations, posted flyers, and online advertisements. Eligible participants for the parent project were English-speaking, community-dwelling adults ( $\geq 18$  years) in the United States who did not have active suicidal ideation and who belonged to  $\geq 1$  stakeholder group: those with “lived experience” of suicide risk (either themselves or a family member); suicide prevention professionals; ED providers; and firearm experts. For this analysis, we included only interviews with adults with “lived experience” of suicide.

### METHODS

One-on-one, semi-structured interviews were conducted between August–December, 2017 via web conference or in

#### *Population Health Research Capsule*

What do we already know about this issue?

*Lethal means counseling (LMC) is an underutilized resource in emergency department care of adults with suicidal ideations or attempts.*

What was the research question?

*We spoke to those with lived experience of suicidal ideation or attempt to learn how LMC resources could be most beneficial to them.*

What was the major finding of the study?

*Engaging suicidal individuals in LMC may be more effective when messaging and approaches consider their emotional state.*

How does this improve population health?

*By learning from adults with lived experience, we will be better able to design and implement resources to be used by suicidal individuals.*

person. All interviews lasted approximately 45 minutes and were recorded and professionally transcribed. At the end of the interview, participants completed a questionnaire about their demographic characteristics and received a \$25 gift card. All participants provided informed consent and the study was approved by the local institutional review board.

Interviewers followed a basic guide using broad, open-ended questions to explore decision support needs (i.e., educational needs of adults in crisis and means by which to elicit personal values relevant to decisions about firearm and medication storage) and elicit feedback on iterative versions of the decision aid. Broad interview domains included the following: participants’ prior experiences with decision-making around firearm or medication storage during times of suicide risk; recommendations for decision aid edits (e.g., messaging, formatting, and imagery); and perception of the decision aid’s ability to influence someone being evaluated in an ED for SI/SA (Appendix). A short questionnaire collected demographic information. A professional research assistant with a background in sociology and qualitative research conducted the interviews and conducted primary data analysis. The study team also included Masters- and doctoral-level clinical social workers and physicians with experience in mixed-methods research, emergency medicine, suicidology, crisis intervention, outpatient behavioral health, and shared decision-making. Field notes written during and immediately after the interviews captured nonverbal cues and in-the-moment global understanding of responses.

For analysis, we used a team-based approach informed

by established mixed deductive and inductive techniques.<sup>17-21</sup> We used Dedoose analytic software v 7.1.3 (SocioCultural Research Consultants, Los Angeles, CA). Through deductive thematic analysis, we interpreted data in the context of the theoretical framework and existing literature. We combined this with an inductive approach to allow identification of new, emerging themes. Through these techniques, we synthesized codes into a core set of themes, and we compared and contrasted our themes with our first cycle of direct speech coding.<sup>20</sup> We organized the final core themes into a preliminary framework about conversations related to the suicidal state. Together these processes provided an in-depth, comprehensive analytic matrix for interpretation.<sup>19,21</sup> Our multidisciplinary team provided multiple perspectives through which to interpret the text data, and we shared the themes and framework with participants during the last set of interviews (“member checking”) to further establish thematic organization. Participants were recruited until thematic saturation was reached. We followed the COREQ guidelines for the conduct and reporting of qualitative research projects.<sup>22</sup>

## RESULTS

We conducted 27 interviews with adults who had lived experience of suicide ideation or attempts in either themselves (n = 14) and/or a family member (n = 23; Table 1). Participants had a mean age of 44 and ranged from 25-70 years old. Two-thirds were male (67%) and 89% were White. Eight participants (30%) were firearm owners.

The interviews yielded 450 pages of transcript data and 34 pages of memos. Two dominant themes emerged related to how

the affective state of a suicidal person can challenge reasoning and information processing. First, the dominance of emotionality over rationality was seen as a barrier to interventions for an individual in crisis. Second, participants proposed strategies to overcome these challenges through designing interventions with attention to high emotionality. These strategies address three subthemes: initiation; engagement; and context (Table 2).

### Affective State

Participants spoke to the state of mind of individuals with suicidal thoughts or behaviors, including how that state differs from a non-suicidal state. One said, “*When I’m feeling great, I would think I would never grab a firearm and blow my brains out. But when I’m feeling horrible and spiraling down, of course it’s gonna come across my mind.*” When asked about making decisions within this context, interviewees discussed the specific challenges in making decisions posed by the high emotionality of people in crisis. Specifically, they noted LMC tools designed by clinicians and researchers – individuals in rational states – could function poorly for those in a heightened emotional state.

*“When people get into that crisis mode, they’re already overwhelmed. If they’re at the ER or they’re at anywhere, clearly their own resources aren’t working anymore. If you were to tell them, ‘Hey, come up with a plan to keep yourself safe,’ they wouldn’t know what to do. They’d say, ‘That’s why I’m here.’ Versus, ‘Pick some things on this list. All of them are good options. Which one’s the best for you?’ I think it can be a lot less taxing.”*

**Table 1.** Characteristics of interview participants (n = 27).

Age (median, IQR, range)	44 (35-50; range 25-70)
Female (n, %)	18 (67%)
Race (≥1 allowed)	
White	24 (89%)
Black	3 (11%)
American Indian/Alaska Native	1 (4%)
Hispanic	5 (19%)
Veteran	3 (11%)
Residence in mostly rural area	5 (19%)
Work in mostly rural area	3 (11%)
Stakeholder group affiliation (≥1 allowed)	
Personal history of suicidal thoughts or attempt	14 (52%)
Family member of someone with suicidal thoughts, attempt, or death	23 (85%)
Firearm owner or enthusiast	8 (30%)
Work at/with firearm retailer, range, or organization	2 (7%)
Work in suicide prevention (including volunteering)	18 (67%)
Healthcare provider	10 (37%)
Work/affiliated with VA or other veteran service provider	4 (15%)

IQR, interquartile range; VA, Veterans Affairs.

This distinction, as described by a participant, spoke to the need for directed suggestions that guide an individual in making a decision, rather than general counseling about the need to do something without suggested, concrete actions. Another participant elaborated on the importance of providers giving simple steps or clear options to individuals in a suicidal crisis but more detailed information to supporting family or friends (who likely are in a more rational state).

*“Wait, so what – is there an answer to this? Like, ‘how do I easily store a weapon if I have one?’ And it was sort of like just – it was almost overwhelming with information. Like I don’t – especially like having been someone who has that sort of crisis mindset, I would look at that and be like, ‘I just don’t know what I’m supposed to do. Can you please just tell me what to do?’ would be sort of how I would have approached it if I were the patient. So I think a simple recommendation, like, ‘You could – here are three ways you can store your guns,’ you know, would be easier than the pros and cons of each of the ways. Although, I think that information could be really valuable for families who are making better decisions and in a better sort of headspace to be able to analyze information; I think that could be helpful.”*

Participants described how too much information can be overwhelming for someone in crisis and emphasized the need for simplicity and identifying someone who can act as support.

**Challenges to Helping an Individual at Risk of Suicide to Make Decisions**

*Initiation*

The first challenge identified was how best to initiate discussions with someone in a state of high emotionality (i.e., with acute SI/SA) to discuss lethal means safety and to look at the

decision aid. Interviewees discussed that making decisions and digesting information can be difficult, highlighting the need for streamlined graphics and parsimonious text in the decision aid. As one said, *“I wonder if there is a way to do both that doesn’t take up too much space, ‘cause this I think already if you’ve got a person in crisis they’re gonna kind of look at it and go ‘oh my god.’ [Laughs] I think it could be a little overwhelming.”* In sharing this idea, this participant is suggesting the need for clear, simplified information. Supportive messages were also identified as a strategy to encourage connection and initiation of decision aid use (Table 2), including explicit acknowledgement that stress can alter a person’s usual cognitive or decision-making abilities. One participant said: *“You can’t predict that in any person on a normal day, I don’t think, or a group of people on a normal day, and then extrapolating it for each crisis.... I think, you know, ‘when we’re in crisis we’re not quite as we would be otherwise,’ so kind of breaking it down.”* This participant acknowledged that designing and developing resources for any group of people has challenges, and that with high emotionality there is a need for more directness and for accessible language.

*Ongoing engagement*

Once the conversation is initiated, the second challenge identified was how to maintain the attention of the person in the crisis, including how to keep them engaged during LMC and when they return home. Gathering the name and contact information of another individual was suggested as a way to encourage connection to others and maintaining safety-focused changes. The timing of when to encourage individuals in crisis to identify collateral sources of support was also seen as critical.

*“I could see that if somebody just in the moment filling this out, they might be interested in putting in, say, somebody’s email address because they’re in the moment. But as they*

**Table 2.** Representative quotes, by challenges and strategies.

Theme	Challenge	Strategy
Initiation	“I think starting off with something, especially if you are in fact feeling helpless or alone, that starts off with “This tool can help you make a decision,” it sounds like work. [Laughs] And that’s probably the last thing you’re thinking about in that situation.”	“So to my eye the ‘You may feel helpless and alone right now’ probably catches somebody who is feeling helpless and alone and then pulls them in.”
Engagement	“‘Preferences, Logistics and Other Issues,’ that sounds pretty cold, really cold, and also kind of technical, that it’s not about a person.”	“So ‘Beliefs and Choices’ or something like that, which is still not too warm and fuzzy, but it’s acknowledging that there’s a human that’s making these decisions.”
Context	“I just don’t think you can hammer the temporary message nearly enough because you think about the history of public health trying to promote safe storage even outside of suicide, like the trigger locks and stuff. ... Most of those things didn’t work because people were like, ‘Well, you’re giving me this really clumsy thing, and I gotta find the key, and I have to hide the key or know the combination or whatever. Then I can’t get it when the burglar breaks in.’ So they already have reasons in their head why anything other than immediate access on the nightstand with a chambered gun is a negative thing.”	“So, in hammering home the temporary thing doesn’t make me think, ‘Oh, they’re asking me to change my lifestyle and in terms of how I interact with this firearm. They’re just asking me to keep...’ Even though obviously that’s what we want ideally, but for these things, if we’re talking temporary, just the advertising principle of repetitive messages.”

*walk out, they may well think twice about actually reaching out for the help. ... They might be in a more vulnerable space in the hospital because they're probably in the conversation and have been talking about suicidal feelings, which means it sounds to me like it would be an opportunity ripe for being able to send an email to somebody saying '[name]'s identified you as the person that he would like to speak to about concerns he had about being safe around his firearms' or something like that because that would allow my wife or whoever I plug into the thing in the moment to hopefully broach the topic as opposed to relying on me after I get home and cool down a bit."*

Participants also identified hopeful, supportive language as useful in maintaining user engagement (Table 2), along with simple, discrete choices as described above. This participant talked us through the pieces behind connecting to someone while the person experiencing SI/SA was still in the hospital. The context of the hospital, and conversations that happen during patient care, can be used as a window into continuous care afterward. As one participant said, *"Just telling them that it's okay to set the guns aside while they're in crisis, like some reassurance, 'cause yeah, I guess when you feel like you can't escape them even if you want to, like what do you do. There's a sense of helplessness and utility there that we're trying to avoid."* Thus, to provide people in crisis with reassurance and encouragement was noted here as helpful in maintaining engagement with resources.

### Context

The third challenge identified was the context in which the conversation about firearm or medication storage was occurring, including the environment (e.g., ED, hospital, or home) and who else was involved in storage. Participants suggested prompts on how to engage people that they trust in the decision about firearm storage, with a recommendation for a large list of potential support individuals (family, friend, neighbor, fellow veteran, etc) to enable suicidal individuals to choose as many as possible, as well as to prompt them to consider people in their social lives who they may not have thought of during this moment of crisis. A participant who works with veterans commented:

*"Maybe under Friend/Family/Neighbor, you could put 'another veteran' or something like that. ... The work that we do is you talk to – you can kind of prime the conversation. It would be like, 'Well, what if your buddy was really struggling? What would you do?' He was like, 'I would get in my car and drive 600 miles to go help him out.' And I said, 'Well, what would your buddy do for you?' He was like, 'I guess they could hold my guns.'"*

The temporary nature of firearm-storage changes for suicide prevention was highlighted as a key concept to reinforce as a way to gain buy-in, encourage behavior change, and reduce

the possibility of defensiveness or the feeling that the goal was to undermine lifestyle choice. Recognizing, as this participant did with their friend, the relationships and supports that exist but may have been overlooked before being prompted through comprehensive listing, is again giving a set of options rather than vague, general directions.

### DISCUSSION

Lethal means counseling for those at risk of suicide, including those evaluated in EDs, is important as it may affect home storage behavior and ultimately may reduce suicide risk.<sup>23,24</sup> This qualitative study highlights key considerations about decision-making during a time of crisis. Participants consistently emphasized the overarching needs related to meeting the needs of people in a state of high emotionality, one characterized by high affective valence and lower rationality with attendant cognitive and communicative challenges. The dominant theme was the need for simplification of information being shared with individuals in a state of high emotionality, along with the need to remind them of their desire for connection with others.

This study highlights our understanding of how patients should be able to engage with available resources in a way that positively impacts home safety choices. Lethal means counseling could work in conjunction with ED-based approaches such as safety planning by engaging clients in identifying the treatment and safety plans that are best for them.<sup>25-27</sup> When identifying strategies related to the challenges of initiation and engagement, participants discussed the need for engaging individuals experiencing crisis collaboratively in their own care, including LMC. This is consistent with the collaborative nature of leading treatment approaches for suicidal thoughts and behavior, as well as with shared decision-making.<sup>28</sup>

For example, in dialectical behavior theory (DBT), clients work collaboratively with a social worker or other behavioral healthcare provider to learn skills to help them regulate suicidal thoughts and rapid emotion escalation, with the understanding that different skills are needed in different times and for different purposes, depending on the circumstances, the goals, and emotional state of the patient.<sup>29</sup> The Collaborative Assessment and Management of Suicidality (CAMS) approach also focuses on collaboration between social workers or other providers and clients in learning to understand the origins of suicidal thoughts, feelings, and behaviors.<sup>30</sup> The CAMS approach encourages clients to engage in developing their own treatment plan and it can be used within various psychotherapies, including potentially through a virtual interface in EDs.<sup>31</sup>

The type and quality of affective, cognitive, and somatic states among those at highest risk of suicide have been previously documented; they include desperation, hopelessness, rage, abandonment, guilt, anxiety, humiliation, sleep disturbance, avolition, and self-hatred.<sup>32,33</sup> This intense emotional state was also highlighted in our interviews. While most social work, psychology, counseling, divinity, and similar programs offer

substantive training in responding to clients experiencing strong emotions, most Masters-trained practitioners (who are typically the behavioral health specialists working in EDs) report feeling inadequately prepared to work with clients during their periods of highest suicide risk.<sup>34,35</sup> These include assistance in reviewing resources and a collaborative approach to identifying concrete next steps. Training resources exist, such as CALM (counseling on access to lethal means) to help support behavioral health and other providers feel confident in engaging in this collaborative LMC working during and after a suicidal crisis.<sup>25</sup>

Overall, the framing that participants felt would be most helpful was addressing the facts in a digestible fashion while still encouraging confidence in the person in crisis. In doing this, participants shared sentiment that reflected the transition between someone in a highly charged emotional state and someone in a typical, more rational, deliberative state, where they could successfully participate in their own care. Seeking and incorporating insight from those who have been in this state of mind can help make approaches such as LMC more accessible to clients, in the same way that CAMS, safety planning, and certain components of DBT are structured to engage clients in their own care.<sup>27,29,30</sup>

This project lent itself to the understanding of the difficulty inherent in reflecting on being in a “hot state” when one is in a “cold state” – including for the individuals interviewed in this project. The “hot-cold empathy gap”<sup>36</sup> highlights how it could be possible that reflections and recommendations made by those in a cold state of high rationality might underestimate the volatility of preferences among those in a state of emotionality. While none of our participants identified this dynamic by name, many of them did allude to the labile nature of cognitive processes they either experienced or observed in their loved ones during suicidal crises, and advocated for conservative approaches to communication, facilitation of discussion with healthcare providers, and use of decision support tools.

## LIMITATIONS

Among the limitations of this study was that interviews did not focus solely on the topic discussed here. Thus, although our analysis included 27 individuals, generalizability may be limited. Participation was voluntary with a small incentive, so interviewees may have been particularly passionate about the subject. We did, however, use snowball sampling to contact additional interviewees identified by participants as having unique or influential perspectives. Our interviews did not discuss how intoxication with alcohol or other substances may further affect the cognitive state of an individual with suicide risk. Given the frequent co-occurrence of intoxication and suicidality among ED patients, this is an area that merits further study. Finally, our interviews were in the context of receiving feedback on our specific LMC decision aid. The feedback discussed here is based on broader ideas shared by participants about the considerations needed when communicating with this population of people in crisis.

## CONCLUSION

A key component of care of suicidal individuals in acute care settings – and one that is a policy- and evidence-supported and scalable intervention – is lethal means counseling to reduce access to firearms and other methods of suicide. Incorporating the perspectives of individuals with personal or family-lived experience with suicide can enhance development and delivery of interventions in the ED. Specifically, interventions for those with acute suicide risk should consider the emotional and cognitive states, and needs, of those patients. Directed, digestible information that is supportive, with concrete steps could encourage both collaboration, independence, and engagement in care.

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*Address for Correspondence:* Bonnie J. Siry, MSSc, University of Colorado School of Medicine, Department of Emergency Medicine, 12401 East 17th Avenue, B215, Aurora, CO 80045. Email: bonnie.siry-bove@cuanschutz.edu.

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# Patient Characteristics and Perspectives of Firearm Safety Discussions in the Emergency Department

Lauren Hudak, MD, MPH\*

Henry Schwimmer, MD<sup>†</sup>

William Warnock, BA<sup>‡</sup>

Sarah Kilborn, MD<sup>§</sup>

Tim Moran, PhD\*

Jeremy Ackerman, MD, PhD\*

Jonathan Rupp, PhD\*

\*Emory University, Department of Emergency Medicine, Atlanta, Georgia

<sup>†</sup>Alameda Health System, Highland Hospital, Department of Emergency Medicine, Oakland, California

<sup>‡</sup>Emory University, School of Medicine, Atlanta, Georgia

<sup>§</sup>Vanderbilt University, Department of Emergency Medicine, Nashville, Tennessee

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**Introduction:** Firearm injury prevention discussions with emergency department (ED) patients provide a unique opportunity to prevent death and injury in high-risk patient groups. Building mutual understanding of safe firearm practices between patients and providers will aid the development of effective interventions. Examining ED patient baseline characteristics, perspectives on healthcare-based safety discussions, and experience with and access to firearms, will allow practitioners to craft more effective messaging and interventions.

**Methods:** Using an institutional review board-approved cross-sectional survey modified from a validated national instrument, we recruited 625 patients from three large, urban, academically affiliated EDs in the South to assess patient baseline characteristics, perspectives regarding firearms and firearm safety discussions, and prior violence history, as well as firearm access and safety habits. We compared the degree to which patients were open to discussions regarding firearms across a variety of provider types and clinical scenarios between those with and without gun access.

**Results:** Of the 625 patients consented and eligible for the study, 306 had access to firearms. The patients with firearm access were predominantly male, were more likely to have military experience, live in an urban or suburban region, and have experienced prior violence when compared to those without firearm access. Patients with and without gun access view firearm safety discussions with their healthcare provider as acceptable and analogous to other behavioral health interventions (i.e., helmet/seat belt use, alcohol/cigarette use). Patients were also accepting of these firearm safety discussions in many clinical contexts and led by multiple provider types. Of the patients with gun access, storage of each type of firearm was reviewed and the primary reason for ownership was for personal protection across all firearm types.

**Conclusion:** Patients in the ED indicate openness to firearm safety discussions delivered by a variety of providers and in diverse clinical scenarios. Healthcare providers engaging firearm owners in appropriate risk-benefit discussions using a trauma-informed approach is a critical next step in research and intervention. [West J Emerg Med. 2021;22(4.1):54-63.]

## INTRODUCTION

Although firearm injury is widely recognized as a public health epidemic responsible for approximately 40,000 deaths and 130,000 injuries in the United States in 2017 alone, the field has a dearth of rigorous research to guide effective intervention strategies.<sup>1</sup> Additionally, there is limited research addressing firearm injury prevention in the healthcare setting, likely contributing to a lack of engagement and general discomfort with the subject among patients and providers. Despite healthcare providers and medical societies advocating for firearm injury risk and safety discussions with patients,<sup>2</sup> a minority of providers report initiating these conversations.<sup>3</sup> Given concern for rising numbers of violence-related injuries,<sup>4</sup> increased social isolation, and prevalence of mental health problems,<sup>5,6</sup> as well as escalating firearm and ammunition purchases during the COVID-19 pandemic,<sup>7,8</sup> these discussions are more critical now than ever. In fact, physicians and other healthcare providers are uniquely positioned to address this issue, as other potential avenues for intervention are limited due to social distancing and other lockdown measures.

Prior studies have touched on important elements to consider when addressing firearm safety in healthcare populations. The 2015 National Firearm Survey (NFS) used a nationally representative, web-based sample to estimate that 54.7 million people in the US own guns.<sup>9</sup> Additionally, two-thirds of non-firearm owners and over one-half of firearm owners felt it is “at least sometimes appropriate” for physicians and other healthcare providers to discuss firearm safety with patients.<sup>10</sup> Another study using the NFS sample examined the responses of veterans. They concluded that half of veterans own at least one firearm, with the majority owning both handguns and long guns, citing personal protection as the primary reason for ownership.<sup>11</sup> These findings provide an important glimpse into firearm ownership and potential translational healthcare applications. However, the NFS was not designed solely for healthcare-based intervention and thus did not sample from patients in a clinical environment and did not expand upon potentially relevant healthcare-focused variables. Assessing patients’ degree of openness to firearm discussions with different healthcare provider types in specific clinical scenarios is an important next step in firearm injury prevention research.

Another study of 200 ED patients that used a 22-item survey to assess patient demographics, access to firearms, and general attitude toward healthcare-based screening comes closer to understanding ED patients’ views on firearm safety discussions. Their findings indicate the majority of both gun owning (100%) and non-owning patients (87.5%) felt comfortable discussing firearm safety with their healthcare provider, and a majority of patients felt these discussions would result in safer firearm storage changes.<sup>12</sup> The patients’ views of different provider types conducting firearm safety discussions and clinical scenarios in which safety discussions are appropriate was not reported. Neither patients’ history of violence nor reasons for gun ownership were reported.

### *Population Health Research Capsule*

What do we already know about this issue?  
*Healthcare providers engaging patients in firearm safety discussions is emerging as a promising opportunity to prevent associated firearm injury and death.*

What was the research question?  
*What are the characteristics of patients and in which clinical scenarios are firearm safety discussions acceptable?*

What was the major finding of the study?  
*ED patients are open to firearm safety discussions delivered by a variety of providers and in diverse clinical scenarios.*

How does this improve population health?  
*Healthcare providers can engage patients in firearm safety discussions with the goal of reducing risk for firearm injury and death.*

More broadly, healthcare interventions that involve firearm safety or storage counseling, such as lethal means counseling, have become established as effective in healthcare populations, especially in suicidal adult and pediatric mental health populations.<sup>13,14</sup> These interventions have gained traction in ED settings,<sup>3,15-17</sup> with a focus on providers building knowledge about firearms and safety practices in an effort to build cultural competence to better engage gun owners in safety discussions and primary prevention.<sup>18</sup> Such efforts have improved our understanding of healthcare-focused safety discussions. Further exploring the factors that contribute to ED patient attitudes and potential receptivity to intervention is critical to advancing the field and saving lives.

This cross-sectional study addresses these gaps in understanding by surveying the attitudes and experiences of ED patients. The knowledge gained directly contributes to the development of effective intervention with ED patients by evaluating their baseline demographics, firearm-related discussion perspectives, prior experience of violence, and firearm access and safety practices.

## METHODS

After institutional review board approval, registered ED patients were approached by trained research assistants (RA) during convenience sample shifts from 7 AM-7 PM, seven days per week in three academically affiliated urban EDs in Atlanta, Georgia, from October 2018–April 2019. The largest hospital, with annual ED visit volume of approximately

142,000, is a Level I trauma center serving mainly an urban, largely underinsured population. The second hospital, with approximately 74,000 annual ED visits, also serves an urban patient population as a community-affiliated academic medical center. The third ED, a tertiary medical center on an academic campus has approximately 51,000 annual visits. Eligible patients were those who did not meet exclusion criteria (<18 years of age, non-English literate, cognitively impaired, medically unstable, in police custody, had previously participated) and from whom verbal informed consent was obtained prior to enrollment. Survey instruments were administered using Apple iPads (Apple, Inc., Cupertino, CA) and REDCap, a web-based software program compliant with the Healthcare Insurance Portability and Accountability Act of 1996. Question types included five-point Likert-type, multiple choice, binary yes/no, and free-text responses, and questions were presented only when relevant to the patient using branching logic (up to 198 questions). After providing consent, the RAs instructed patients on self-administration of the survey using the tablet computers. Patients who declined participation were asked a reason for their decision, and if provided, the RA recorded their response in the free-text portion of the approach section.

### Survey Domains

The survey is divided into three domain areas: 1) demographic information; 2) firearm-related perspectives and past experiences; and 3) firearm access and safety habits. Participants were not permitted to return to prior forms when the domain was completed. Demographic variables of interest included age, gender, race, ethnicity, marital status, housing type/region, education, employment status, income, number of children/if housing them, and military status.

The firearm-related perspectives domain contained a wide range of potentially relevant firearm-related attitudes and experiences as well as topics considered important for potential intervention. Less invasive topics were explored first, such as general perspectives on health-related issues, escalating to potentially more invasive topics, such as political views and prior experience of violence. Public health context of firearm discussions relative to other clinical safety discussions, acceptability of different provider types, acceptability of discussing firearm safety in different clinical scenarios, as well as prior violence history were assessed for this phase of the study. For complete survey elements please reference the supplement section.

The firearm access domain ushered participants through a branching logic survey tool to establish current firearm access and safety habits. Firearm “access” is the preferred terminology for the purposes of this study, as it is a more inclusive term compared to personal “ownership,” acknowledging the potential for fluid possession in households or other unforeseeable shared-use situations. To capture the relevant possibilities of firearm access, subjects were asked, “Do you or does anyone else you live with currently own any type of gun?” and “What

type of gun do you own or have access to?” Additionally, the term firearm and gun are used interchangeably for the purposes of this study, with acknowledgment that the term firearm is more inclusive. We obtained detailed assessment of the reason(s) for ownership and location of the firearm(s), as well as storage habit(s) for each firearm.

Firearms were subdivided into handguns, long guns and “other” guns; storage habits and locations were reviewed for each firearm. Handguns include pistols, revolvers, semi-automatic pistols/revolvers, and “other” as designated by the participant. Long guns include shotguns, rifles, modern sporting rifles, and “other” as designated by the participant. Free space was allowed for the patient to elaborate on any “other type of gun” to which they had access. Survey methodology was conducted in alignment with the question types and terminology used in the 2015 National Firearm Survey and validated by independent expert consensus.

### Statistical Analyses

We described continuous variables using medians and interquartile ranges. Categorical variables were described using frequencies and percentages. We compared patient demographics across those with gun access and those without gun access using the Mann-Whitney U test and the  $\chi^2$  test for continuous and categorical variables, respectively. The main outcomes of interest – patient comfort with questions regarding gun access – were compared across groups using separate ordinal logistic, generalized estimating equations for each provider type. We used the generalized estimating equation to account for clustering within hospital. The adjusted regression included age, gender, race, ethnicity, marital status, region, housing, education, income, number of children, and military experience as covariates. Odds ratios and 95% confidence intervals from the analyses are presented. Analyses were conducted using SPSS v.25 (IBM Corporation, Armonk, NY)

### RESULTS

Of the 1482 patients approached by RAs for inclusion in the study, 625 were eligible and consented to participate. Of those patients, 306 patients had access to firearms while 319 did not. A total of 733 patients declined to participate with various reasons provided in a qualitative free-text response. Other than medical/pain-related concerns, patients cited being tired ( $n = 97$ ), that the survey was anticipated to take too long ( $n = 41$ ), or they had already been approached/taken survey ( $n = 13$ ) as common reasons for non-participation. Additionally, some patients declined due to discomfort with firearms as the survey topic ( $n = 41$ ), or dislike of firearms ( $n = 16$ ), or they declined due to some other discomfort with the topic of firearms ( $n = 25$ ).

### Demographics

When comparing those without firearm access to those with access a few key features emerged (Table 1). Study patients with firearm access ( $n = 191$ , 62.4%) were more

**Table 1.** Demographic characteristics of study participants, gun access vs no access.

Characteristic	No access N = 319	Gun access N = 306	Total N = 625	P-value
Age	45 (30 – 56.5)	47.5 (34 – 61)		0.01
Gender				< .001
Female	184 (57.7)	115 (37.6)	299	
Male	135 (42.3)	191 (62.4)	326	
Race				0.02
American Indian/Alaska Native	4 (1.3)	7 (2.3)	11	
Asian	9 (2.8)	6 (2)	15	
Black	221 (69.3)	176 (57.5)	397	
Multiple	15 (4.7)	23 (7.5)	38	
Native Hawaiian	4 (1.3)	9 (2.9)	13	
White	66 (20.7)	85 (27.8)	151	
Ethnicity				0.38
Not Hispanic	296 (92.8)	283 (92.5)	579	
Hispanic	23 (7.2)	23 (7.5)	46	
Marital status				0.002
Divorced	47 (14.7)	45 (14.7)	92	
Married	58 (18.2)	98 (32)	156	
Unmarried couple	25 (7.8)	26 (8.5)	51	
Separated	20 (6.3)	11 (3.6)	31	
Single	156 (48.9)	112 (36.6)	268	
Widowed	13 (4.1)	14 (4.6)	27	
Housing				0.004
Apartment	126 (39.5)	74 (24.2)	200	
House	151 (47.3)	184 (60.1)	335	
Homeless	10 (3.1)	9 (2.9)	19	
Hotel	4 (1.3)	4 (1.3)	8	
Nursing home/assisted living	4 (1.3)	10 (3.3)	14	
Shelter	6 (1.9)	7 (2.3)	13	
Staying with friends/family	18 (5.6)	18 (5.9)	36	
Region				< .001
Rural	26 (8.2)	63 (20.6)	89	
Suburban	113 (35.4)	123 (40.2)	236	
Urban	180 (56.4)	120 (39.2)	300	
Highest education level				0.11
No school or only kindergarten	2 (0.6)	9 (2.9)	11	
Elementary	4 (1.3)	7 (2.3)	11	
Some high school	38 (11.9)	29 (9.5)	67	
High School graduate or GED	105 (32.9)	84 (27.5)	189	
Some college or technical school	101 (31.7)	99 (32.4)	200	
College graduate	69 (21.6)	78 (25.5)	147	
Employment				0.06
Homemaker	16 (5)	11 (3.6)	27	
Student	32 (10)	20 (6.5)	52	
Employed	127 (39.8)	126 (41.2)	253	

Table 1. continued.

Characteristic	No access N = 319	Gun access N = 306	Total N = 625	P-value
Employment				0.06
Out of work (<1 year)	25 (7.8)	19 (6.2)	44	
Out of work (>1 year)	47 (14.7)	35 (11.4)	82	
Retired	50 (15.7)	55 (18)	105	
Self-employed	22 (6.9)	42 (13.7)	64	
Income				0.01
<\$15,000	114 (35.7)	77 (25.2)	191	
\$15,000-25,000	58 (18.2)	45 (14.7)	103	
\$25,000-35,000	35 (11)	36 (11.8)	71	
\$35,000-50,000	33 (10.3)	50 (16.3)	83	
\$50,000-75,000	37 (11.6)	38 (12.4)	75	
<\$75,000	42 (13.2)	60 (19.6)	102	
Number of children				0.02
0	172 (53.9)	125 (40.8)	297	
1	41 (12.9)	44 (14.4)	85	
2	51 (16)	58 (19)	109	
3	25 (7.8)	31 (10.1)	56	
4+	30 (9.4)	48 (15.7)	78	
Number of children in home				0.9
0	206 (64.6)	191 (62.4)	397	
1	49 (15.4)	48 (15.7)	97	
2	33 (10.3)	33 (10.8)	66	
3	15 (4.7)	15 (4.9)	30	
4+	16 (5)	19 (6.2)	35	
Military experience, N (%)	17 (5.3)	42 (13.7)	59	0.001

likely to be male when compared to those without access (n = 135, 42.3%). Black participants formed the majority of both groups (+access n = 176, 57.5%; -access n = 221, 69.3%), but our gun-accessing population self-identified more frequently as White (n = 85, 27.8%) when compared to the no access group (n = 66, 20.7%). Those with firearm access tended to report being married (n = 98, 32.0%) and home-dwelling (n = 184, 60.1%) more often when compared to the non-firearm accessing group (n = 58, 18.2% and n = 151, 47.3%, respectively). The majority of non-firearm accessing individuals reported living in an urban environment (n = 180, 56.4%) in comparison to those with access (n = 120, 39.2%), who were more likely to live in suburban (n = 123, 40.2%) or rural (n = 63, 20.6%) regions. There was no significant difference between education and employment levels in our population, although patients with firearm access were more affluent and had fewer children than the non-access patients. Those with firearm access were also more likely to have military experience (n = 42, 13.7%) than the non-access (n = 17, 5.3%) group.

## Perspectives

### *Firearm Discussions Compared to Other Behavioral Health Discussions*

We reviewed patient opinion regarding the acceptability of firearm-safety discussions relative to analogous behavioral health topics. Patients generally agreed that firearms should be regarded similarly to other public health topics, such as cigarette smoking, alcohol use, and use of helmets and seatbelts. While agreement was high for both those with and without firearm access, those with access agreed to a lesser extent than their non-accessing counterparts (Table 2).

### *Firearm Discussions Comparing Healthcare Provider Types*

As in prior studies, it appears both groups were in agreement that asking about firearms is appropriate. Patients with gun access were less likely to strongly agree that it is appropriate for providers to conduct medically indicated firearm safety discussions compared with patients without access, although they still generally found such discussions acceptable. Of note, both patients with gun access and those

**Table 2.** Opinion of study patients on discussing different public health topics with a provider: gun access vs no gun access.

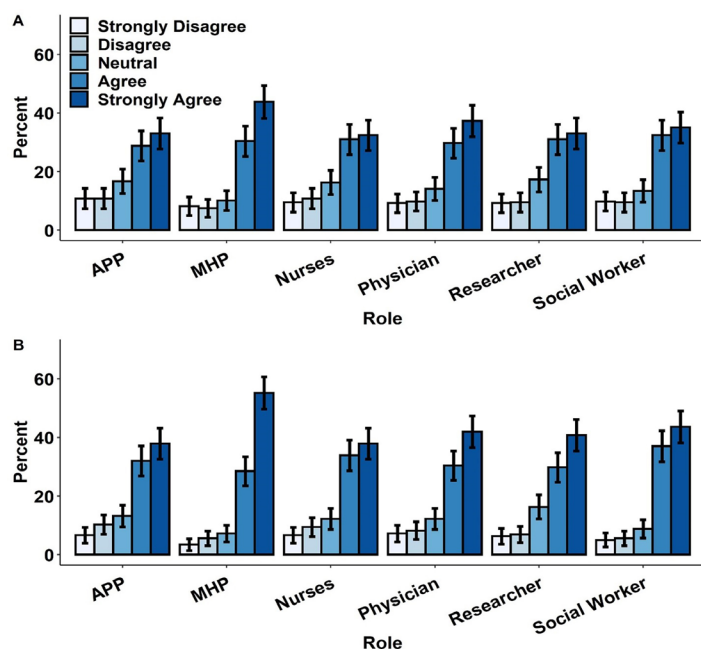
Public health topic	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	OR (95% CI, unadjusted)	OR (95% CI, adjusted)
Smoking cigarettes						0.44 (0.31 – 0.64)	0.45 (0.31 – 0.65)
No access	22 (6.9)	13 (4.1)	8 (2.5)	77 (24.1)	197 (61.8)		
Gun access	40 (13.1)	33 (10.8)	29 (9.5)	70 (22.9)	134 (43.8)		
Drinking alcohol						0.48 (0.32 – 0.72)	0.48 (0.32 – 0.72)
No access	24 (7.5)	14 (4.4)	10 (3.1)	74 (23.2)	197 (61.8)		
Gun access	32 (10.5)	37 (12.1)	26 (8.5)	72 (23.5)	139 (45.4)		
Helmet use						0.60 (0.40 – 0.90)	0.67 (0.44 – 1.02)
No access	18 (5.6)	21 (6.6)	43 (13.5)	91 (28.5)	146 (45.8)		
Gun access	33 (10.8)	42 (13.7)	46 (15)	71 (23.2)	114 (37.3)		
Seatbelt use						0.46 (0.33 – 0.66)	0.52 (0.36 – 0.75)
No access	12 (3.8)	15 (4.7)	30 (9.4)	91 (28.5)	171 (53.6)		
Gun access	39 (12.7)	41 (13.4)	39 (12.7)	65 (21.2)	122 (39.9)		
Gun safety						0.57 (0.4 – 0.79)	0.60 (0.41 – 0.88)
No access	33 (10.3)	27 (8.5)	34 (10.7)	82 (25.7)	143 (44.8)		
Gun access	44 (14.4)	45 (14.7)	46 (15)	71 (23.2)	100 (32.7)		

OR, odds ratio; CI, confidence interval.

**Table 3.** Opinion of patients regarding provider type initiating firearm safety discussions, gun access vs no gun access.

Provider type that can ask about gun access if medically indicated	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	OR (95% CI, unadjusted)	OR (95% CI, adjusted)
Physician						0.81 (0.59 – 1.09)	0.98 (0.67 – 1.42)
No access	23 (7.2)	26 (8.1)	39 (12.2)	97 (30.4)	134 (42.0)		
Gun access	28 (9.2)	30 (9.8)	43 (14.1)	91 (29.7)	114 (37.3)		
APP						0.74 (0.53 – 1.02)	0.85 (0.59 – 1.22)
No access	21 (6.6)	33 (10.3)	42 (13.2)	102 (32.0)	121 (37.9)		
Gun access	33 (10.8)	33 (10.8)	51 (16.7)	88 (28.8)	101 (33.0)		
Nurse						0.73 (0.54 – 0.99)	0.82 (0.57 – 1.19)
No access	21 (6.6)	30 (9.4)	39 (12.2)	108 (33.9)	121 (37.9)		
Gun access	29 (9.5)	33 (10.8)	50 (16.3)	95 (31.0)	99 (32.4)		
Social Worker						0.61 (0.44 – 0.86)	0.67 (0.45 – 0.99)
No access	16 (5.0)	18 (5.6)	28 (8.8)	118 (37.0)	139 (43.6)		
Gun access	30 (9.8)	29 (9.5)	41 (13.4)	99 (32.4)	107 (35.0)		
MHP						0.60 (0.42 – 0.86)	0.73 (0.49 – 1.09)
No access	11 (3.4)	18 (5.6)	23 (7.2)	91 (28.5)	176 (55.2)		
Gun access	25 (8.2)	23 (7.5)	31 (10.1)	93 (30.4)	134 (43.8)		
Researchers						0.72 (0.51 – 1.01)	0.76 (0.51 – 1.13)
No access	20 (6.3)	22 (6.9)	52 (16.3)	95 (29.8)	130 (40.8)		
Gun access	28 (9.2)	29 (9.5)	53 (17.3)	95 (31.0)	101 (33.0)		

APP, advanced practice provider, MHP, mental health provider, OR, odds ratio, CI, confidence interval.



**Figure 1.** Patient degree of agreement that discussing with each provider type is appropriate in A (patients with gun access) and B (patients without gun access). Error bars represent 95% confidence intervals.

APP, advanced practice providers; MHP, mental health professional.

without access agreed that it was most appropriate to have gun safety discussions with mental health providers followed by physicians, while discussions with nurses and researchers were marginally less appropriate but still acceptable overall. (Table 3, Figure 1)

#### Firearm Discussions in Various Clinical Scenarios

Patients were generally in agreement that it is appropriate to discuss firearm risk/safety across multiple clinical scenarios. Both the firearm access and no access groups agreed ( $P$ -value <.001) that providers can ask about firearms in the following clinical scenarios: personal and family depressed/suffering from mental health issues; children in the home; personal or family memory problems; cases of suspected domestic violence; and victim or perpetrator of violent injury. As with the provider type, while both patients with and without access to firearms generally believed it was appropriate to discuss firearms in these contexts, agreement was lower for those with access (Table 4).

#### Patient Past Experience of Violence

Past experience of violence was highly prevalent for both those with and without access to firearms. Notably, those with access to firearms experienced significantly more workplace violence ( $n = 70$ , 22.9%) and had been shot ( $n = 62$ , 20.3%) significantly more than those with no access ( $n = 22$ , 6.9% and  $n = 23$ , 7.2% respectively). Additionally, those with access were more likely to report having been “pistol whipped” or

struck with a gun ( $n = 56$ , 18% vs  $n = 28$ , 8.8%), unintentionally shooting themselves or others ( $n = 56$ , 18% vs  $n = 28$ , 8.8%), and reporting medical treatment due to firearm-related injury ( $n = 73$ , 23.9% vs  $n = 11$ , 3.4%) than those without access. Other types of violence such as physical violence, sexual violence, and domestic violence, while prevalent, did not differ significantly between groups (Table 5).

#### Access

Gun-accessing patients made up about half of the sample with 306 of 625 participants total having access to firearms. Of the handguns reviewed, 19.1% of patients indicated that they stored them “loaded and unlocked,” which is regarded as the least safe of possible options. Long guns followed a similar pattern with 19.3% of patients storing them “loaded and unlocked.” Conversely, 31.9% of patients’ handguns and 33.3% of patients’ long guns were designated as “unloaded and locked,” which is regarded as the safest of possible options. Of patients’ “other guns” category, 29.7% of patients stored them “loaded and unlocked,” while 23.1% stored them “unloaded and locked” (Table 6).

Patients with firearm access indicated that their primary reason for ownership was for “personal protection” inclusive of protection against both “strangers” and “people I know.” Handguns were owned for “personal protection” (84.3%) followed distantly by “hunting” (23.4%), “other sporting use” (15.7%), “some other reason” (14.0%), and “collection/hobby” (13.2%). For long guns, “personal protection” still led (67%) with “hunting” by a closer margin (46%), and “other sporting use” (28.0%), “collection/hobby” (26.0%), and “some other reason” (9.3%) following thereafter. Other guns were owned for “personal protection” in the majority of cases (67.0%) followed by “some other reason” (33.0%), “other sporting use” (12.1%), and “collection/hobby” (11.0%).

#### DISCUSSION

Firearm injury prevention and safety discussions in the healthcare setting are emerging as promising intervention opportunities to reduce injury burden on communities. By surveying patients in three clinically diverse ED populations, we sought to better understand the motivations, attitudes, and experiences of patients likely to be the focus of future safety intervention. The degree of firearm ownership with various demographic groups tends to mirror national estimates, with a large proportion of gun-accessing patients being male with prior military service, but a higher degree of patients self-identifying as Black, living in an urban or suburban region in this particular sample. Consistent with prior studies, patients reported being open to firearm discussions with their doctor or healthcare provider, suggesting support for potential clinical interventions.

In this study, patients generally regarded firearm safety discussions as similar to other clinically relevant topics such as helmet use, seatbelt wearing, and substance use counseling. Furthermore, novel findings support that patients (both firearm

**Table 4.** Opinion of patients on providers asking about access to guns in various clinical settings, gun access vs no gun access.

It is ok for providers to ask patient about access to guns	Strongly Disagree, N (%)	Disagree, N (%)	Neither Agree nor Disagree, N (%)	Agree, N (%)	Strongly Agree, N (%)	P-value
If depressed/ suffering from mental health						< .001
No access	22 (6.9)	21 (6.6)	15 (4.7)	73 (22.9)	188 (58.9)	
Gun access	39 (12.7)	36 (11.8)	39 (12.7)	65 (21.2)	127 (41.5)	
If family depressed/ suffering from mental health						< .001
No access	20 (6.3)	22 (6.9)	18 (5.6)	76 (23.8)	183 (57.4)	
Gun access	38 (12.4)	43 (14.1)	44 (14.4)	62 (20.3)	119 (38.9)	
If there are children in the home						< .001
No access	19 (6)	17 (5.3)	31 (9.7)	72 (22.6)	180 (56.4)	
Gun access	43 (14.1)	40 (13.1)	39 (12.7)	63 (20.6)	121 (39.5)	
If I am elderly/ have memory problems						< .001
No access	21 (6.6)	22 (6.9)	33 (10.3)	68 (21.3)	175 (54.9)	
Gun access	44 (14.4)	40 (13.1)	48 (15.7)	54 (17.6)	120 (39.2)	
If family member is elderly/ has memory problems						< .001
No access	20 (6.3)	29 (9.1)	36 (11.3)	63 (19.7)	171 (53.6)	
Gun access	37 (12.1)	48 (15.7)	45 (14.7)	66 (21.6)	110 (35.9)	
In cases of suspected domestic violence						< .001
No access	22 (6.9)	20 (6.3)	20 (6.3)	60 (18.8)	197 (61.8)	
Gun access	41 (13.4)	42 (13.7)	38 (12.4)	58 (19)	127 (41.5)	
If I am the victim of violent injury						< .001
No access	20 (6.3)	24 (7.5)	22 (6.9)	73 (22.9)	180 (56.4)	
Gun access	37 (12.1)	44 (14.4)	43 (14.1)	58 (19)	124 (40.5)	
If I am the perpetrator of violent injury						< .001
No access	21 (6.6)	23 (7.2)	22 (6.9)	61 (19.1)	192 (60.2)	
Gun access	35 (11.4)	33 (10.8)	49 (16)	59 (19.3)	130 (42.5)	

P-values were computed using the  $\chi^2$  test.

accessing and not) find firearm safety discussions acceptable and appropriate in a wide variety of clinical scenarios and coming from diverse healthcare provider types, which has not been explored in prior research settings. Somewhat surprisingly, the investigators found a very high prevalence of violent victimization in the study population. The number of firearm-accessing patients who had been shot, pistol whipped, or had accidentally shot themselves or others merits further analysis and research attention. Patients claim personal protection as their primary reason for ownership across all firearm types, which has implications for future intervention counseling, especially when considering the potential for history of violent victimization. Handguns, the firearm type most associated with self-inflicted and interpersonal

violence,<sup>19</sup> were not stored in the safest manner, “unloaded and locked,” providing potential room for further exploration and intervention in this high-risk population.

The results presented here lend investigators a more informed perspective when approaching firearm safety discussions in a largely urban population with a high prevalence of violence. By tailoring risk-benefit and safety counseling discussions to local customs, norms, and attitudes, future interventions can be pursued using a regionally relevant, evidence-based framework. Additionally, the findings here support the growing body of evidence calling for interventions that emphasize a trauma-informed approach<sup>20</sup> to ensure future intervention approaches recognize the impact of past violence on patient attitude, behavior, and health.

**Table 5.** History of violence among study patients, gun access vs no gun access.

Violent experience type, N (%)	No gun access	Gun access	P-value
Victim of physical violence	103 (32.3)	121 (39.5)	0.1
Was a gun used?	36 (35)	48 (39.7)	0.56
Victim of sexual violence	54 (16.9)	68 (22.2)	0.21
Was a gun used?	13 (24.1)	25 (36.8)	0.19
Victim of domestic violence	77 (24.1)	86 (28.1)	0.36
Was a gun used?	13 (16.9)	27 (31.4)	0.049
Workplace violence	22 (6.9)	70 (22.9)	0.01
Was a gun used?	6 (27.3)	22 (31.4)	0.92
Been shot	23 (7.2)	62 (20.3)	0.01
Been struck/pistol whipped	28 (8.8)	56 (18.3)	0.01
Accidentally shot self/others	8 (2.5)	42 (13.7)	< .001
Needed medical treatment	11 (3.4)	73 (23.9)	< .001
Other injury after threatened by gun	21 (6.6)	41 (13.4)	0.047
Gang affiliation	10 (3.1)	3 (1)	0.11

P-values were computed using the  $\chi^2$  test.

## LIMITATIONS

There are multiple limitations when interpreting the results of this study. Patients were recruited from three clinically diverse urban, southern EDs, with a large proportion self-identifying as Black and lower income, with a high prevalence of violent victimization. The results may not be generalizable to other regions or different demographic groups. Additionally, the inherent nature of survey-based methodology introduces the potential for sampling bias, participant response bias, and question-order bias. Efforts to reduce the effects of these biases were made in constructing the survey based on prior national, validated survey instruments and validating the new survey instrument through

extensive piloting and expert review. The ability to lock each survey domain was used in an effort to limit participant response bias, especially with respect to the perspectives and access survey-domain responses.

Another limitation of the study was survey length. In particular, the firearm-accessing respondents had the potential to receive up to 198 questions. Efforts to reduce survey length were created by using branching logic question templates to reduce unnecessary questioning and tailor questions specific to the respondent. Unfortunately, the survey length could have resulted in answer fatigue and bias in survey responses. Encouragement prompts were used in the survey instrument in an effort to pace participants, as were RAs trained to assist if interruptions occurred. The extensive questioning also poses its own limitation in that the vast amount of data for potential review limited the ability to present all interesting and potentially relevant findings and will require subsequent analyses to further explore the population nuances in future research.

**Table 6.** Patient primary reason for gun ownership and gun storage method.

	Handgun	Long gun	Other gun
Reason for owning, N (%)			
Hunting	55 (23.4)	69 (46)	0 (0)
Personal protection	198 (84.3)	92 (61.3)	61 (67)
Collection/hobby	31 (13.2)	39 (26)	10 (11)
Other sporting use	37 (15.7)	42 (28)	11 (12.1)
Some other reason	33 (14)	14 (9.3)	30 (33)
Storage method, N (%)			
Loaded and unlocked	45 (19.1)	29 (19.3)	27 (29.7)
Unloaded and unlocked	75 (31.9)	33 (22)	18 (19.8)
Loaded and locked	75 (31.9)	39 (26)	25 (27.5)
Unloaded and locked	40 (17)	50 (33.3)	21 (23.1)

## CONCLUSION

Firearm safety discussions in the ED are well accepted by patients and can be delivered by a variety of providers in diverse clinical scenarios. This concept builds upon research supporting such safety discussions in healthcare populations, despite perceived potential discomfort experienced by both providers and patients. Engaging firearm owners in respectful, culturally appropriate risk-benefit discussions with trained providers offers a promising opportunity to improve safety and storage habits in high-risk populations. Furthermore, using a trauma-informed approach, especially considering patient past experience of violence, should be considered and further explored in future research.

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*Address for Correspondence:* Lauren Hudak, MD, MPH, Injury Prevention Research Center at Emory, 49 Jesse Hill Jr. Drive SE, Atlanta, GA, 30303, Steiner Building, Suite 116. Email: lhudak@emory.edu.

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# Gun Violence and Firearm Injuries in West Michigan: Targeting Prevention

Christopher M. Mattson, DO\*

Ryan Kaylor, DO<sup>†</sup>

Tracy J. Koehler, PhD<sup>‡</sup>

Marc Ydenberg, MD\*

Justin Grill, DO\*

Brian R. Stork, MD<sup>§</sup>

\*Mercy Health, Department of Emergency Medicine, Muskegon, Michigan

<sup>†</sup>Naval Medical Center, Department of Emergency Medicine, San Diego, California

<sup>‡</sup>Mercy Health, Department of Scholarly Activity Support, Muskegon, Michigan

<sup>§</sup>University of Michigan, Department of Urology, Ann Arbor, Michigan

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**Introduction:** Firearm-related deaths and injuries are ongoing public health issues in the United States. We reviewed a series of gun violence- and firearm-related injuries treated at a multi-campus community healthcare system in West Michigan to better understand the demographic and clinical characteristics of these injuries. We also studied hospital charges, and payers responsible, in an effort to identify stakeholders and opportunities for community- and hospital-based prevention.

**Methods:** We performed a retrospective review of firearm injuries treated at Mercy Health Muskegon (MHM) between May 1, 2015 and June 30, 2019. Demographic data, injury type, Injury Severity Score (ISS), anatomic location and organ systems involved, length of stay (LOS), mortality, time of year, and ZIP code in which the injury occurred were reviewed, as were hospital charges and payers responsible.

**Results:** Of those reviewed, 307 firearm-related injuries met inclusion criteria for the study. In 69.4% of cases the injury type was attempted murder or intent to do bodily harm. Accidental and self-inflicted injuries accounted for 25% of cases. There was a statistically significant difference in the mechanism of injury between Black and White patients with a higher proportion of Black men injured due to gun violence ( $P < 0.001$ ). Median ISS was 8 and the most commonly injured organ system was musculoskeletal. Median LOS was one day. Self-inflicted firearm injuries had the highest rate of mortality (50%) followed by attempted murder (7%) and accidental discharge (3.1%;  $P < 0.001$ ). Median hospital charge was \$8,008. In 68% of cases, Medicaid was the payer. MHM received \$4.98 million dollars in reimbursement from Medicaid; however, when direct and indirect costs were taken into account, a loss of \$12,648 was observed.

**Conclusion:** Findings from this study reveal that young, Black men are the primary victims of gun violence-related injuries in our West Michigan service area. Hospital care of firearm-related injuries at MHM was predominantly paid for by Medicaid. Multiple stakeholders stand to benefit from funding and supporting community- and hospital-based prevention programs designed to reduce gun violence and firearm-related injuries in our service area. [West J Emerg Med. 2021;22(4.1):64-73.]

## INTRODUCTION

Firearm-related deaths and injuries are ongoing public health issues in the United States (US) and in West Michigan. The

increasing frequency of these events, most recently in prominent cities such as Atlanta, GA and Boulder, CO, has placed a growing toll on communities nationwide, both in terms of morbidity and

mortality, and monetary cost.<sup>1</sup> While mass casualty incidents have historically received the majority of media attention, fatalities in mass shooting incidents in the US account for only a fraction of all gun murders that occur nationwide each year.<sup>2-4</sup> If we define mass casualty incidents as those events involving four or more victims (excluding the shooter), there were 373 reported deaths in 2018.<sup>2</sup> Overall, between 2010–2016 there were more than 595,000 injuries reportedly caused by firearms in the US.<sup>5,6</sup> During that same period, firearms were involved in 8133 deaths in the state of Michigan.<sup>7</sup>

Mercy Health Muskegon (MHM) is a community-based healthcare system located in West Michigan. A member of Trinity Health, MHM through its three hospital campuses provides an estimated 90% of healthcare services to the region it serves.<sup>8</sup> Each campus, by way of its associated emergency department (ED), serves a unique patient population. The system's Hackley and Sherman campuses, for example, serve inner city, suburban, and rural populations. They also accept transfer patients from other hospitals. Alternatively, the Lakeshore campus predominantly serves a rural population. Mercy Health Muskegon established a Level II trauma center on its Hackley Campus on May 1, 2015. The opening of this center has resulted in numerous benefits to the surrounding communities, including having 24-hour access to multiple specialties, a dedicated trauma service, and a trauma coordinator to assist with quality improvement and outcome reporting.

Our goal in this study was to describe the demographic, clinical, and situational characteristics of firearm injuries, as well as outcomes, hospital charges, and payers. This information could be used to support future resource allocation and firearm-related injury prevention efforts.

## METHODS

After obtaining approval from the Mercy Health Grand Rapids Institutional Review Board, we performed a retrospective review of all firearm-related injuries treated at MHM hospital EDs between May 1, 2015–June 30, 2019. These hospitals included Mercy Health Lakeshore Campus, Mercy Health Muskegon Campus, and Mercy Health Hackley Campus. A start date of May 1, 2015, was chosen because it was the first day Mercy Health Hackley Campus began servicing the community as a Level II trauma center. For the purpose of this study, we defined firearm injuries as any injury resulting from the discharge of a firearm with penetration or abrasion to the subject's body by the projectile. We used preselected *International Classification of Diseases*, revisions 9 and 10 (ICD)-9 and ICD-10 diagnostic codes (Supplement 1) to query the hospital charges database to identify patients. After identifying potential charts, two investigators (CM and RK) independently reviewed each patient's chart to ensure it met criteria for inclusion (Figure 1). Of the 381 cases identified by ICD coding, 74 cases were excluded.

Study variables included the following: age; gender; race; mechanism of injury (e.g., attempted murder, accidental, self-inflicted); firearm involved; method of arrival to hospital

### *Population Health Research Capsule*

What do we already know about this issue?

*Firearm related deaths and injuries are a major public health issue in the United States. Though more heavily publicized, mass shootings make up a minority of these events.*

What was the research question?

*Our goal in this study was to describe the demographic, clinical, and situational characteristics of firearm injuries in our community, as well as analyze outcomes, review hospital charges, and track payers.*

What was the major finding of the study?

*Hospital-based care of gun violence injuries in our community is resource intensive, leads to significant Medicare expenditures, and results in a net loss of revenue for our health care system.*

How does this improve population health?

*These findings will support future resource allocation and firearm-related injury prevention efforts in the community.*

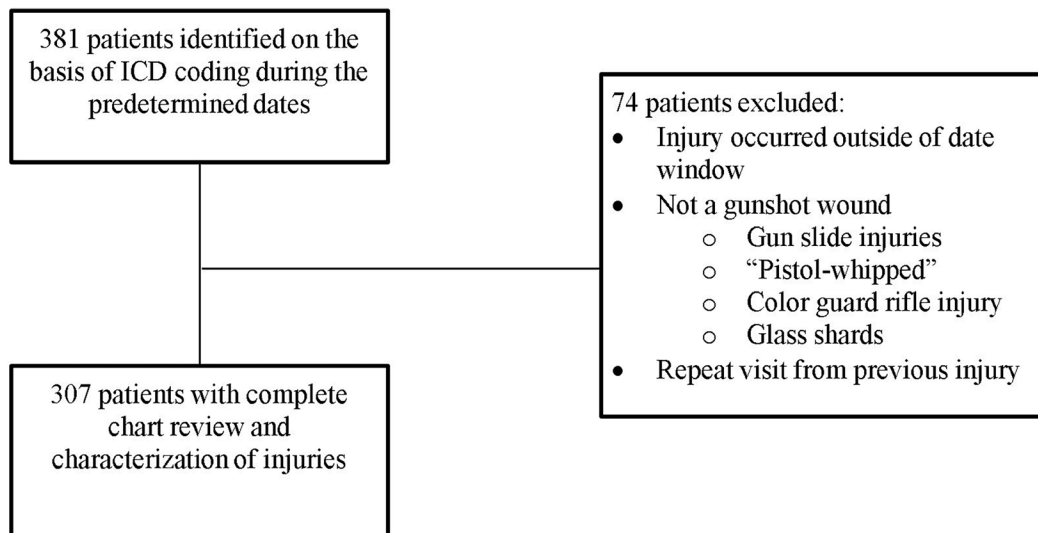
(e.g., ambulance, car); Injury Severity Score (ISS); anatomic location(s) of injury(ies); organ system(s) affected; comorbidities requiring treatment during that visit/stay; length of stay (LOS); mortality; time of year (month); geographic region of injury (ZIP code); hospital charges; and payer. For the purposes of this study, hospital charges included only fees charged by the hospital itself. Other charges related to patient care, such as professional fees charged by emergency physicians, anesthesiologists, and radiologists in private practice, were not captured. Also omitted were charges associated with after-visit care at other facilities (e.g., acute rehabilitation stays, physical therapy visits).

We calculated summary statistics for the data. Quantitative data are shown as mean  $\pm$  standard deviation or median and interquartile range (IQR) or minimum/maximum values for non-normally distributed variables. Nominal data are shown as percentages. Quantitative data were compared using the Kruskal-Wallis test and nominal variables were compared using the chi-square or Fisher's exact test when appropriate. We analyzed data using SPSS Statistics, v. 23 (IBM Corp., Armonk, NY).

## RESULTS

### **Patient and Clinical Characteristics**

A total of 307 firearm-related injuries met inclusion criteria for the study. Table 1 shows the demographic, clinical, and



**Figure 1.** Inclusion flow chart.

firearm injury characteristics of our subjects. The average age was  $27.2 \pm 12.9$  years, and patients were predominantly male. Blacks accounted for more than 70% of injuries. Median ISS was 8 [IQR: 1-15],  $n = 165$ , and less than 10% of patients had other medical comorbidities treated concurrently. The median ISS was significantly lower for injuries related to accidental discharge (1 [IQR: 1-9.3]) when compared to self-inflicted wounds (21 [IQR: 6.5-25];  $P = 0.002$ ) as well as between accidental discharge and attempted murder/bodily harm (9 [IQR: 2.5-14];  $P = 0.03$ ). Table 2 depicts comparisons by mechanism of injury.

### Injury-Related Characteristics

Nearly 70% of injuries were the result of attempted murder and were due to single rather than multiple gunshot wounds. There was a statistically significant difference in the rates of mechanism of injury between Black and White patients ( $P < 0.001$ ). A higher proportion of Blacks were injured due to attempted murder, compared with Whites (85% vs 40%), whereas rates of accidental discharge and self-inflicted injuries were higher in White patients (47% vs 12.7% and 13% vs 2%, respectively). Patients with self-inflicted injuries were significantly older than patients with injuries from an attempted murder or bodily harm (39 [25.7-62] vs 25 [19-31.5];  $P = 0.011$ ), as well as for self-inflicted injuries and accidental discharge (22 [17.3-34.8];  $P = 0.008$ ; Table 2). Handguns were the most common type of weapon used; however, weapon type was documented in only 33% of cases. Mode of transportation to the ED was split closely between private vehicle/walk-in and ambulance arrival. Injury location and body system involved are shown in Figure 2A and 2B. The majority of injuries were to the distal extremities. Musculoskeletal injuries accounted for the bulk of cases (70%), ranging from compound fractures to mild musculoskeletal tears. Other organ system injuries occurred much less frequently.

### Mortality, Length of Stay, and Hospital Charges

Tables 2 and 3 show results related to mechanism of injury comparisons and overall LOS, survival, hospital charges, and payers, respectively. More than 90% of visits related to firearm injuries were non-fatal, resulting in a median LOS of one day. Self-inflicted firearm injuries had the highest rate of mortality (50%) compared with attempted murder (7%) and accidental discharge (3.1%;  $P < 0.001$ ). Median LOS in survivors was significantly different between injuries related to accidental discharge compared with self-inflicted (1 [IQR: 1-1] vs 2 [IQR: 1-3];  $P = 0.007$ , respectively) as well as between accidental discharge injuries and attempted murder/bodily harm (1 [IQR: 1-3];  $P < 0.001$ ). Of the 26 fatalities, 19 were due to a non-self-inflicted cause, and 7 were attributed to the victims themselves. Total hospital charges for patients treated for firearm-related injuries were \$6.37 million. Median hospital charge was \$8,008 [IQR: \$2,024–\$21,716]. Median charges were significantly lower for accidental injuries compared with attempted murder/bodily harm injuries (\$1381 [IQR: \$825–\$10,041] vs \$10,184 [IQR: 3314–\$31,250];  $P < 0.001$ ) and self-inflicted injuries (\$19,508 [IQR: 10,849–\$25,921];  $P < 0.001$ ). Hospital reimbursement for the care of the majority of patients (67.8%) was provided by Medicaid. When direct and indirect costs were taken into consideration, MHM reported a \$12,648 loss on the care of these patients (Nagengast, CPA, FHFMA, and C. Kosheba [personal communication, July 27, 2020]).

### Time of Year and Region

The number of firearm injuries by time of year is shown in Figure 3. Most occurred during the summer months. When comparing by time of year (e.g., winter: December-February; spring: March-May; summer: June-August; and fall: September-November) this trend was not statistically significant ( $P = 0.54$ ; Table 2). Of injuries recorded, 79%

**Table 1.** Demographic, clinical and firearm injury characteristics, N = 307.

Characteristic	No. (%) <sup>^</sup>
Age, years*	27.7 ± 12.9
Gender	
Male	273 (88.9)
Female	34 (11.1)
Race	
Black	224 (73.0)
White	81 (26.4)
Multiracial	2 (0.7)
Ethnicity	
Hispanic/Latino	9 (2.9)
Injury Severity Score, (n = 165) <sup>#</sup>	8 [1-15]
Patients receiving treatment for comorbidities during management of firearm injury	17 (5.5)
Mechanism of injury	
Attempted murder	213 (69.4)
Accidental discharge/mishandling of a weapon	64 (20.8)
Other/unknown	16 (5.2)
Self-inflicted	14 (4.6)
Mechanism of arrival (n = 304)	
Ambulance	154 (50.7)
Private vehicle/walking	150 (48.9)
Previous gun injury	18 (5.9)
Projectile number	
Single gunshot	240 (78.2)
Multiple gunshots	67 (21.8)
Weapon type (n = 99)	
Handgun	61 (61.6)
Shotgun	6 (6.1)
Long gun	3 (3)
BB gun/air gun	29 (29.3)
Treating location	
Hackley Hospital (inner city)	253 (82.4)
Mercy Health Muskegon (inner city)	46 (15)
Lakeshore Hospital (rural)	8 (2.6)

<sup>^</sup>Unless otherwise noted.

\*Mean ± standard deviation.

<sup>#</sup>Median [interquartile range].

occurred within two ZIP codes, which included the cities of Muskegon and Muskegon Heights.

## DISCUSSION

Our results showed more than 90% of visits related to firearm injuries were non-fatal, with ISS scores on the lower end resulting in a median LOS of one day. This appears to be

the result of numerous superficial or distal injuries not requiring prolonged (or any) hospitalization. Many patients were discharged home on the same day as their presentation to the ED. Most injuries occurred within two ZIP codes served by our hospital system with the majority occurring during the warmer months of the year. Characteristics of the patient population and mechanism of injury included high rates of attempted murder/bodily injury involving Black males. These findings are similar to previous demographic studies of gun violence injuries in other communities.<sup>1,9,10</sup> Accidental discharge injuries were associated with lower ISS, LOS, and hospital charges, whereas self-inflicted injuries occurred mainly in older adults and were more expensive with higher mortality rates.

## Violent Crime

The high incidence of firearm-related injuries has received intense scrutiny throughout the nation. In 2018, firearm-related violence made up 26.1% of all aggravated assaults in the United States.<sup>11</sup> Recently, gun violence has again erupted in cities such as Atlanta, GA and Boulder, CO, highlighting the continued relevance. During our defined study period, Michigan State Police reported 618 cases involving a firearm in Muskegon County, 36 of which resulted in death.<sup>12</sup> As a result, Mercy Health EDs are frequently charged with caring for the victims of firearm injuries.

Blacks were victims of 73% of all firearm-related injuries during the study period. Furthermore, of the 226 events where ZIP code was recorded, we found 80% were clustered within 49442 and 49444. These ZIP codes include the cities of Muskegon and Muskegon Heights. A 2016 FBI statistics report showed the 49442 and 49444 ZIP codes were home to some of the highest violent crimes per capita in the state.<sup>13</sup> These same areas have a 74.5% Black population with a poverty rate of 37.9% (national poverty rate estimated to be approximately 15.7%).<sup>14</sup> The Muskegon County population (containing both cities previously described) is estimated to be 81.2% White, 14% Black, and 5.8% Hispanic or Latino, for comparison.<sup>14</sup> Multiple peer-reviewed sources note that individuals suffering from low socioeconomic status are at increased risk for both committing and being victims of violent crime.<sup>15,16</sup> The apparent racial disparity appears to be related to socioeconomic conditions and increased poverty rates in the local Black community, particularly in these areas.

Researchers have attempted to identify individuals who are at increased risk for interpersonal violence. Goldstick et al developed the SaFETY score as a way to predict future firearm violence. This risk-stratification tool identifies very high-risk individuals (e.g., those with a SaFETY score > 5) who are likely candidates for entry into resource-intensive programs.<sup>17</sup> Similarly, Kramer et al<sup>18</sup> established an algorithmic tool to predict violent reinjury, the “Violent Reinjury Risk Assessment Instrument,” which could help with resource allocation.

In addition to risk stratification, the Flint Youth Injury

Study noted a strong relationship between substance use and violence among a high-risk urban minority sample.<sup>19</sup> Addressing substance use and poverty and improving the socioeconomic status of all American ethnic groups should be of paramount importance. This may require a significant amount of government and private aid in combination with public policy reform over several years and perhaps even decades. A better short-term solution may be to address gaps in public education and to provide more outreach programs.<sup>19,20</sup>

The American Association for the Surgery of Trauma Prevention Committee recommends hospital-based violence intervention programs (HVIP) as a means of reducing interpersonal violence.<sup>21</sup> Throughout the country, physicians and hospital systems have joined the effort to help reduce gun violence in their respective communities with some success.<sup>1,22</sup> Between 1999–2001, for example, the R. Adams Cowley Shock Trauma Center in Baltimore, MD, implemented and reviewed a HVIP.<sup>23</sup> This model used a multidisciplinary approach, including conflict resolution and public safety issues, recovery from injury, development of positive skills/support, and connection to community services. The center was able to demonstrate a firearm injury recidivism rate for program participants of 5%, compared with a 36% recidivism rate for the control group not receiving violence intervention services, which translated to a cost difference of \$598,000 between groups.<sup>23</sup>

Two additional HVIPs, Within Our Reach and the Wraparound Project, tested a varying degree of social services to prevent re-injury in patients. The first program used a control group that was provided simply a written list of

services, whereas the treatment group received an assessment and case management for six months. Both groups were evaluated at six and 12 months after enrollment in the study; overall they noted a 12.2% reduction in self-reported re-injury in the intervention group (20.4% vs 8.1%).<sup>24</sup> The latter project focused on meeting the needs of patients in two specific domains: mental health and employment. In their HVIP, they were able to demonstrate a recidivism rate of 4.5% vs the historical control of 16%.<sup>25</sup>

Prescription for Hope (RxH) took a unique approach: RxH support specialists conduct an in-depth assessment of patients admitted with a violent injury. They provide a tailored plan with a multitude of community services and after analysis of eight years of data demonstrated a 4.4% recidivism rate among program participants.<sup>26</sup>

The cities of Muskegon and Muskegon Heights have also taken steps to address the gun violence in parts of their cities. For example, in June 2019 a local fundraiser supported by police departments in Muskegon County and Meijer, Inc., created the first annual Guns for Groceries Community Health and Safety Day. This “no questions asked” program allowed citizens to exchange any type of weapon, to be appropriately disposed of by the Muskegon Heights Police Department, for a \$100 grocery gift card. It was reported that 137 guns, ranging from rifles to shotguns were collected.<sup>27</sup> That same month, religious, community, and business leaders began a series of town hall meetings called Gaining Unity Through Non-Violent Solutions or G.U.N.S. These meetings served as an opportunity for community members to think about and

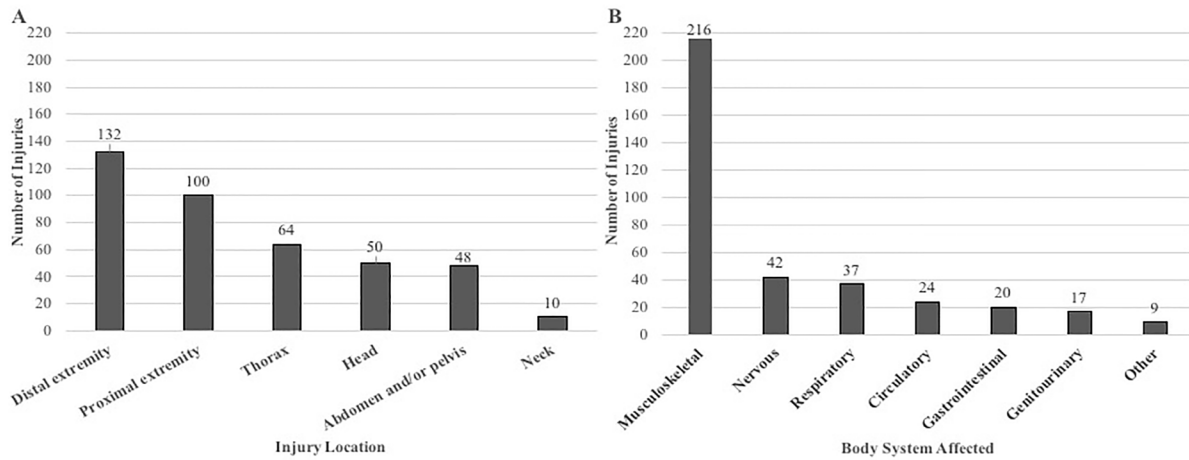
**Table 2.** Mechanism of injury comparisons.

Characteristic	Attempted murder/bodily harm n=213	Accidental discharge n=64	Self-inflicted n=14	P-value
Age*	25 [19-31.5] <sup>#</sup>	22 [17.3-34.8] <sup>^</sup>	39 [25.7-62] <sup>#^</sup>	0.011 <sup>#</sup> ; 0.008 <sup>^</sup>
Race, No. (%)				
Black	182 (85.4)	27 (12.7)	4 (1.9)	<0.001
White	31 (40.3)	36 (46.8)	10 (13)	
Injury Severity Score*	9 [2.5-14] <sup>#</sup> n=124	1 [1- 9.3] <sup>#^</sup> n=18	21 [6.5-25] <sup>^</sup> n=12	0.03 <sup>#</sup> ; 0.002 <sup>^</sup>
LOS, survivors	1 [1-3] <sup>#</sup> n=198	1 [1-1] <sup>#^</sup> n=62	2 [1-3] <sup>^</sup> n=7	<0.001 <sup>#</sup> ; 0.007 <sup>^</sup>
Mortality, No. (%)	15 (7)	2 (3.1)	7 (50)	<0.001
Hospital charges*	\$10,184 [\$3,314-\$31,250]	\$1381 [\$825-\$10,041]	\$19,508 [\$10,849-\$25,921]	<0.001
Time of year, No. (%)				
Fall	43 (20.4)	11 (17.2)	2 (14.3)	
Spring	61 (28.9)	17 (26.6)	2 (14.3)	0.54
Summer	62 (29.4)	24 (37.5)	4 (28.6)	
Winter	45 (21.3)	12 (18.8)	6 (42.9)	

\*Median [interquartile range].

Superscripts #, ^ denote the comparison between columns and their associated significant P-value.

LOS, length of stay.



**Figure 2.** A) Firearm injury frequency by body area(s); B) body system(s) affected.

openly discuss ways that they could work together to better support at-risk youth and reduce violence.<sup>28</sup> In 2019, G.U.N.S. held a fundraising basketball game in conjunction with local law enforcement to help increase awareness in the community. The event was so successful that the organization planned to make it an annual event.<sup>29</sup>

Our study data, combined with grass root efforts ongoing in the MHM service area and the fact that successful, healthcare-led prevention programs already exist in other cities, suggest that a physician-led, hospital-based program and clinical screening tool to reduce gun violence would further benefit our community. This would have the potential to not only improve the health and safety of at-risk persons in our service area, but also reduce preventable healthcare utilization and costs.

**Accidental Injury**

Within the study period there were 65 firearm injuries classified as “accidental injuries.” The bulk of this group was made up of young (average age 28), White (57.1%) males (78.1%). These specific types of injuries carried a low mortality rate of only 3.1%. Reasons for gun ownership in Michigan vary from person to person, including protection/safety, hunting, sport shooting, collector pieces, and vocational requirements. Limited reporting prevented our ability to statistically evaluate the events and mechanisms that caused these “accidental injuries”; however, common accidents we found included self-inflicted injury from mishandling a weapon (cleaning, loading, or playing with the weapon) and hunting/sport shooting accidents.

Currently, several organizations offer firearm training courses, some free to the public, in and around Muskegon County. These gun safety courses teach general firearm safety rules: how to safely store your weapon; the fundamentals of holding, loading, and shooting the weapon; and some courses provide combat preparation for high-stress situations. Further gun safety and training outreach should be considered for the

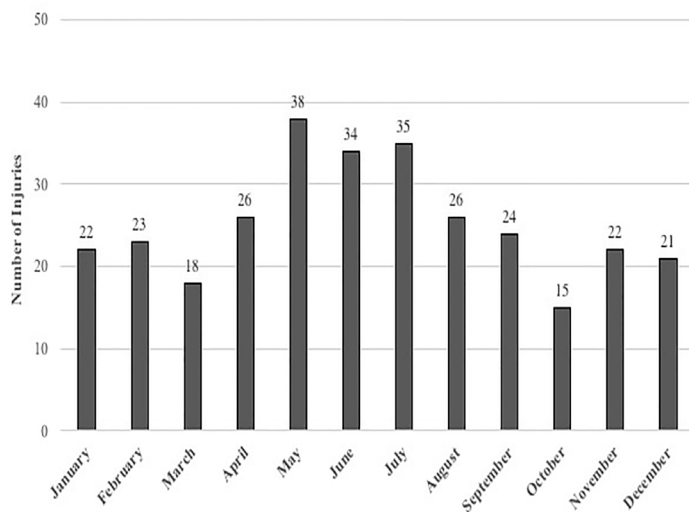
local communities of West Michigan to reduce the number of “accidental injuries” from firearms. Most, if not all, cases are preventable with better knowledge and safety precautions.<sup>30</sup>

In addition, due to the plentiful game and numerous opportunities for hunting in the state of Michigan, there are a large number of registered hunters. As mentioned above, hunting and hunting-related activities are potential causes for firearm-related deaths and injuries. In contrast to our expectations, only a handful of cases were attributed to hunting-related activities in our study group. In general, the MHM ED sees few hunting-related accidents. This could be attributed to the fact that hunting in this area is often a family activity, where there is supervision from a parent or guardian. Credit could also be given to state regulations mandating that all new hunters born on or after January 1, 1960, must obtain a “hunter safety certificate.”<sup>31</sup> According to Michigan’s Department of Natural Resources (DNR, in the 10 years leading up to 2019, there were only 20 hunting-related fatalities in Michigan and 122 injuries. The DNR has tracked a steady decline in firearm-injury

**Table 3.** Outcomes, payer and cost information, N = 307.

Outcome	Value
Length of stay, days <sup>#</sup>	1 (1-29)
Mortality, No. (%)	26 (8.5)
Payer	No. (%); total charges
Public aid	208 (67.8%); \$4,979,964
Commercial insurance	30 (9.8%); \$447,875
Blue Cross/Blue Shield	27 (8.8%); \$344,555
Uninsured	24 (7.8%); \$283,624
Medicare	15 (4.9%); \$283,394
Other	3 (1.0%); \$30,303

<sup>#</sup>Median (minimum – maximum values).



**Figure 3.** Frequency of firearm injuries in Michigan by month for study period.

incidents since 1977, when they began to require hunters to wear orange in the field and improved safety courses.<sup>32</sup>

Another confounding variable increasing “accidental firearm injuries” is the mishandling by unregistered users, specifically children who gain access to unsecured weapons. A 2005 study showed that locking up firearms and ammunition reduced the risk of self-inflicted firearm injury by 78%, and lowered risk of accidental pediatric firearm injury by 85% compared with no intervention.<sup>30</sup> Another study in 2019 estimated that if half of households with children attempted to lock up their firearms, up to one third of youth gun suicide and accidental deaths could be prevented.<sup>33</sup> Currently there is a national ad campaign called “End Family Fire,” endorsed by at least 25 different organizations, whose aim is to decrease the number of incidents of accidental firearm injury/death related to inadequate safe gun-storage practices.<sup>34</sup> Another impressive resource is “Project Child Safe,” a program supported by the National Shooting Sports Foundation.<sup>35</sup> They partner with local law enforcement throughout the nation to provide free cable-style gun locks with safety instructions to better secure one’s firearms.

### Intentional Self-inflicted Injury

There were 14 “intentional or self-inflicted” firearm-injury cases reported in our study group. The majority of these injuries occurred in White (71.4%) men (78.6%), with a mean age of 42.5 years old. Seven cases, or 50%, resulted in mortality for the victim. The mortality rate in this group was the highest when compared with all other firearm injury groups.

According to aggregated data from the Centers for Disease Control and Prevention, in 2017 the rate of suicide in the US was approximately 14 victims per 100,000 persons.<sup>36</sup> This equated to roughly 42,700 suicides across the nation that year.<sup>36</sup> Moreover, the rate of suicide within the State of Michigan was

also 14.1 victims per 100,000 persons.<sup>37</sup> Although attempted murder and homicide often make headlines, in most counties in Michigan it is actually suicide and suicide attempts that make up the largest number of firearm-related injuries. Between 2008–2013, for example, only three counties in Michigan reported more homicides than suicides.<sup>38</sup> For our purposes, the county of Muskegon reported a much higher suicide rate than the national average at roughly 17.9 victims per 100,000 persons.<sup>37</sup> This equated to 71 suicides by firearm in the county between 2015–2019.<sup>39</sup> Initially we found it difficult to explain why, given the higher than average suicide rate in our community, we were seeing so few firearm-related suicide victims in our EDs. After speaking with local law enforcement officials we now believe this is likely due to the fact that suicide attempts involving guns are very often fatal and that these patients many times die outside of the hospital and never actually make it to the ED.<sup>40</sup>

The high rate of “self-inflicted injuries” and mortality associated with these injuries in Muskegon County is distressing; however, local data-driven groups such as the Muskegon County Suicide Prevention Coalition are actively working to reverse this trend. Beginning in 2006, these groups crafted a broad plan to reduce overall deaths by suicide. Their guiding principles are to promote awareness, reduce stigma and barriers, increase protective factors and reduce risk factors, promote community resources, and to be data driven.<sup>41</sup> To improve suicide prevention and gun safety, they are working with community leaders and healthcare officials in Muskegon to implement outreach programs.<sup>42</sup> For example, there is free online training for healthcare professionals called CALM (counseling on access to lethal means) provided through the Suicide Prevention Resource Center. This educational course helps providers identify red flags and reduce the access to lethal means, such as firearms and medications.<sup>43</sup>

### LIMITATIONS

We used ICD-9 and -10 codes, specific to firearm-related injuries, to collect cases that occurred at MHM and its Level II trauma center. Cases that were mislabeled or coded with an alternative ICD 9/10 code may not have been captured. Neither did we capture the number of individuals who suffered mortality before transport. In addition, the type of weapon involved was only documented 33% of the time. On the basis of electronic health record charting alone, it is difficult to make any definitive statements about the types of firearms responsible for injuries in our community. Further investigation and an emphasis on improving provider documentation of weapon type is recommended. Injury Severity Score data were recorded in only 53.7% of cases. This may be due in part to the fact that in accordance with the hospitals’ trauma registry inclusion criteria, injury scores were not calculated for patients who were treated and discharged directly from the ED (M. Kucera RN, BSN, Trauma Program Manager, [personal communication, January 5, 2021]).

In addition, we used hospital charges to the patient/insurer to quantify economic burden. It should be noted that analyzing hospital charges alone does not properly represent the total burden to each patient. This total omits bills issued by private providers and groups (anesthesiologists, radiologists, emergency physicians, etc) or private ambulance services. Furthermore, it does not include any costs incurred after discharge from the hospital, which include acute rehabilitation, visiting nurses, and physical therapy. Victims' legal fees and lost income/wages as a result of injuries sustained from a firearm were not a part of this study.

We obtained the data in this study from three different MHM EDs in West Michigan. As the frequency and nature of gun violence can vary significantly by community, the results of this study may not be generalizable to other EDs, hospitals, or communities.

## CONCLUSION

In this study, younger Black males were identified to be the primary victims of gun violence-related injuries in our service area. Hospital visits for these injuries were associated with a net monetary loss for the hospital system and high burden to Medicaid. Review of the literature supports a multi-disciplinary approach to firearm-related injury reduction and costs associated with their care. Hospital-based intervention programs partnered with community resources are an effective tool for injury recidivism and cost reduction. Moving forward, the institution of a hospital-based intervention program with emphasis on the identified high-risk population offers an opportunity to help prevent recurrent injury and decrease financial costs for the system.

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*Address for Correspondence:* Christopher Mattson, DO, Mercy Health, Department of Emergency Medicine, 1675 Leahy St. Suite 315A, Muskegon, MI 49442. Email: Christopher.M.Mattson@mercyhealth.com.

*Conflicts of Interest:* By the WestJEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

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# Firearm Exposure and Storage Practices in the Homes of Rural Adolescents

Charles A. Jennissen, MD\*†

Kristel M. Wetjen, BSN‡

Cole C. Wymore, BS\*

Nicholas R. Stange, BS¶

Gerene M. Denning, PhD\*

Junlin Liao, PhD§

Kelly E. Wood, MD†

\*University of Iowa Carver College of Medicine, Department of Emergency Medicine, Iowa City, Iowa

†University of Iowa Carver College of Medicine, Stead Family Department of Pediatrics, Iowa City, Iowa

‡University of Iowa Stead Family Children's Hospital, Department of Surgery, Iowa City, Iowa

§University of Iowa Hospitals and Clinics, Department of Surgery, Iowa City, Iowa

¶Saint Louis University School of Medicine, St. Louis, Missouri

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**Introduction:** Rural areas have higher rates of firearm-related unintentional and suicide deaths. Having access to a firearm greatly increases suicide risk. Safe firearm storage can be a major factor in preventing these tragedies. In this study we evaluated firearm exposure and storage practices in rural adolescents' homes.

**Methods:** An anonymous survey was administered to a convenience sample of attendees at the 2019 Iowa FFA (formerly Future Farmers of America) Leadership Conference. We performed descriptive, bivariate and multivariable logistic regression analyses.

**Results:** A total of 1,382 adolescents participated; 51% were males and 49% were females. Respondents were 13-18 years old, and 53% lived on a farm, 18% in the country/not on a farm, and 29% in town. Almost all (96%) self-identified as White/Caucasian. In their homes, 84% reported having rifles/shotguns, 58% reported having handguns, and 56% reported having both rifles/shotguns and handguns. Males were significantly more likely than females to report having firearms in their home ( $P < 0.001$ ). The likelihood of having rifles/shotguns was greater if living on a farm (odds ratio (OR) 4.19, 95% confidence interval (CI), 2.99-5.88) or in the country/not a farm (OR 2.74, 95% CI, 1.78-4.24) compared to those in town. Similarly, the presence of handguns in the home was increased if living on a farm compared to in town (OR 1.70, 95% CI 1.32-2.18). Rifles/shotguns and handguns were stored unlocked and/or loaded at least some of the time in 62% and 58% of homes, respectively. Those who lived on farms compared to in towns were more likely to have rifles/shotguns (OR 1.83, 95% CI 1.35-2.46) and handguns (OR 1.58, 95% CI 1.10-2.27) stored unlocked. For homes with unlocked rifles/shotguns, 46% stored ammunition unlocked. For homes with unlocked handguns, 38% stored ammunition unlocked. Among those aware of firearm storage in their home, 82% (802/974) reported at least one firearm stored either unlocked and/or loaded at least some of the time.

**Conclusion:** The vast majority of rural adolescents we surveyed live in homes with firearms, and a large proportion of those firearms are not stored safely. Widespread efforts are needed to educate rural families about the importance of proper firearm and ammunition storage. [West J Emerg Med. 2021;22(4.1):74-85.]

## INTRODUCTION

Firearm-related injuries in the United States (US) are the second leading cause of child and adolescent death, and the nation's pediatric mortality rate from firearms is the highest in the world.<sup>1-3</sup> According to World Health Organization data, the US pediatric firearm-related unintentional and suicide death rates for victims 5-14 years old were 12 and 11 times greater, respectively, than those of 23 other industrialized countries.<sup>3</sup> The firearm-related death rate for children 0-4 years old was 33 times higher.<sup>3</sup> Moreover, from 2013–2017 the fatality rate for youth in the US increased by 44%.<sup>4</sup>

Although pediatric firearm injuries may be intentional (eg, homicide, suicide), a large proportion are unintentional. In fact, more than half of pediatric admissions for firearm injuries in children 15 years and younger are for unintentional injuries.<sup>5</sup> <sup>6</sup> The majority of unintentional firearm fatalities in children occur in the home, and most occur when the child is playing with a loaded firearm.<sup>7</sup> In the US, approximately one-third of homes with children have a firearm present, and it is estimated that approximately 4.6 million US children live in homes with a firearm stored unlocked and loaded.<sup>8,9</sup>

Suicide rates among America's youth are increasing, and tripled for those 10-14 years old from 1999 to 2014.<sup>10-12</sup> Suicide attempts by firearms are highly lethal with over 90% resulting in death.<sup>13</sup> In one study, 65% of youths who committed or attempted suicide by firearm obtained the gun from their home.<sup>14</sup> Having access to a firearm increases the likelihood of suicide among youth.<sup>11</sup>

Several studies have shown that firearm-related unintentional and suicide death rates are higher in rural as compared to urban US counties.<sup>15-17</sup> In 2019, the Firearm Safety Among Children and Teens (FACTS) Consortium identified as a research priority understanding how the availability, storage, and presence of a firearm in the home affects youth outcomes.<sup>18</sup> The objective of our study was to determine firearm exposure and storage practices in the homes of rural adolescents, and to identify demographic factors associated with having firearms present and unsafely stored in the home.

## METHODS

### Study Population

This was a cross-sectional survey study of a convenience sample of adolescents attending the 2019 Iowa FFA Leadership Conference. FFA (formerly known as Future Farmers of America) is a national organization with local chapters in all 50 states and Puerto Rico. Membership is free, and the organization offers students leadership, personal growth, and career success training through agricultural education. Conference attendees volunteered and anonymously completed a written survey at the study institution's injury prevention booth. Surveys were completed independently and reviewed by safety-booth staff for completeness. Following the survey, participants were given the opportunity to ask questions about gun safety, offered

### Population Health Research Capsule

What do we already know about this issue?  
*Rural areas have higher rates of firearm-related unintentional and suicide deaths. In the majority of these tragedies, the gun involved was obtained from the home.*

What was the research question?  
*We sought to determine firearm exposure and storage practices in the homes of rural adolescents who attended a state conference.*

What was the major finding of the study?  
*Eighty-five percent of adolescents lived in a home with a firearm. In many homes, firearms and ammunition were stored unsafely.*

How does this improve population health?  
*Understanding firearm practices in the homes of rural adolescents will lead to evidence-based education to help prevent firearm-related death and injury.*

printed safety materials, and allowed to spin a wheel for a small prize. All conference attendees were eligible to complete the survey, but study analysis was restricted to those 13-18 years of age.

### Survey

The survey was developed at the study institution by members of the Injury Prevention Task Force and other individuals interested in firearm injury prevention through a collaborative and iterative process. The survey tool was validated by 20 youth and young adults ages 11-22 years. After completing the written survey, these volunteers explained their responses to the questions and were asked to clarify their answers if a question was not understood. Verbal and written responses to questions were compared for consistency. The survey was revised based on the results.

Demographic data collected included age (years), gender (male, female, other), residence (on a farm, in the country/not on a farm, in town), and race (White/Caucasian, Black/African American, Hispanic Latinx, Asian, other). The five individuals who answered "other" for gender were not included in comparative analyses. Races/ethnicities besides White/Caucasian were categorized as "other races" for study purposes. Study data collected included the presence of firearms and firearm storage methods in the participant's home. On the survey, the term "firearm" was defined as a weapon "from which a bullet or other projectile is fired by

gunpowder,” and did not include BB guns, pellet guns, or dart guns. The term “home” included “the place you sleep and all other buildings your family owns on the same property.” A firearm was considered “unlocked” if it was “not locked in a storage place or not stored with a trigger lock or cable.”

Participants were asked if there were any rifles/shotguns and/or handguns in their home with responses “yes” and “not that I know of.” The latter was used instead of “no” as some adolescents may not be aware of firearms in the home. If the respondent answered “yes” for either the presence of rifles/shotguns or handguns, they were separately asked if these firearms were stored loaded, unlocked, or both loaded and unlocked. Answers for each included “Yes/Always,” “Yes/Sometimes,” “No,” and “Not sure.” Those responding “Not sure” were not included in comparative analyses. A firearm was considered safely stored if it was always stored unloaded and locked. Any firearm stored at least sometimes loaded and/or unlocked was considered unsafely stored.

### Data Analysis

The surveys were completed on paper and provided to the research team for analysis. The institutional review board deemed the research exempt as analysis was done on an anonymously collected existing dataset. We entered data into survey software (Qualtrics International, Inc, Provo, UT). Aggregate results were then exported as an Excel spreadsheet (Microsoft Corp, Redmond, WA) and imported into Stata 15.1 (StataCorp, College Station, TX). We performed descriptive (frequencies), bivariate (chi square, Fisher’s exact test), and multivariable logistic regression analyses. All *P*-values were two-tailed, and a value <0.05 was considered statistically significant. Missing data were not included in analyses.

## RESULTS

### Subject Demographics

A total of 1382 adolescents were included in analysis. The proportion of males and females was nearly equivalent (Table 1). Almost two-thirds were 16-18 years old. More than half lived on a farm, almost one-fifth resided in the country/not on a farm, and 29% lived in town. The vast majority (96%) were White/Caucasian.

### Firearms in the Home

Over four-fifths (84%) of respondents reported that at least one rifle or shotgun was present in their homes, and 58% reported the presence of at least one handgun (Table 1). More than one-half (56%) indicated that both rifles/shotguns and handguns were present in their homes. Only 2% of respondents reported having handguns only, and 27% reported rifles/shotguns only.

### Comparison of Rifle/Shotgun Presence in the Home

Males, older teens, and participants identifying as White/Caucasian had significantly higher percentages reporting a

**Table 1.** Demographic and firearm-related variables of adolescent survey respondents.

	n (Col%) <sup>a</sup>
Group N	1382
Gender	
Male	697 (51%)
Female	680 (49%)
Age	
13 years	29 (2%)
14 years	120 (9%)
15 years	330 (24%)
16 years	363 (26%)
17 years	321 (23%)
18 years	219 (16%)
Residence	
Farm	727 (53%)
Country/not a farm	250 (18%)
Town	400 (29%)
Race	
White/Caucasian	1,320 (96%)
Other races	61 (4%)
Rifle/shotgun in home	
Yes	1,159 (84%)
Not that I know of	223 (16%)
Handgun in home	
Yes	802 (58%)
Not that I know of	580 (42%)
Combined firearms in home	
Both rifle and handgun	780 (56%)
Rifle/shotgun only	379 (27%)
Handgun only	22 (2%)
None that I know of	201 (15%)

<sup>a</sup>The sum of n may not equal the total Group N due to missing values.

rifle/shotgun in the home as compared to their peers (Table 2). Participants who lived on a farm more frequently reported rifles/shotguns in the home than those residing in the country/not on a farm, (*P*<0.0001). Additionally, a higher proportion of both of these groups reported the presence of rifles/shotguns in their homes as compared to respondents who lived in town. Logistic regression analysis demonstrated that males were 2.4 times more likely than females, and that other races were 40% less likely than Whites/Caucasians to report at least one rifle/shotgun in the home. Those living on a farm and those living in the country/not on a farm were 4.2 and 2.7 times more likely, respectively, to report the presence of rifles/shotguns in the home than those residing in town.

### Comparison of Handgun Presence in the Home

Significantly more male respondents reported handguns in the home as compared to females (Table 3). In terms of residence, the frequency of reporting the presence of a handgun in the home was on a farm > in the country/not on a farm > in town, overall *P*<0.001. Logistic regression analysis showed that

**Table 2.** Bivariate and multivariate logistic regression analyses regarding the presence of rifles/shotguns in the homes of adolescent survey respondents.

	Crosstab analysis			Logistic regression analysis	
	Yes n (Row %) <sup>b</sup>	No <sup>a</sup> n (Row %) <sup>b</sup>	P-value	Odds ratio	Confidence interval
Group N	1,159 (84%)	223 (16%)			
Gender			<i>P</i> < 0.001		
Male	626 (90%)	71 (10%)		2.43	1.77-3.35
Female	530 (78%)	150 (22%)		1.0 (ref)	
Age			<i>P</i> = 0.072		
16-18 years	769 (85%)	134 (15%)		1.29	0.94-1.77
13-15 years	390 (81%)	89 (19%)		1.0 (ref)	
Residence			<i>P</i> < 0.001		
Farm	660 (91%)	67 (9%)		4.19	2.99-5.88
Country/not a farm	216 (86%)	34 (14%)		2.74	1.78-4.24
Town	279 (70%)	121 (30%)		1.0 (ref)	
Race			<i>P</i> < 0.001		
White/Caucasian	1,118 (85%)	202 (15%)		1.0 (ref)	
Other races	40 (66%)	21 (34%)		0.43	0.24-0.78

<sup>a</sup>The actual response was “Not that I know of” as homes may have had firearms but the adolescent respondent may not have known that they were present.

<sup>b</sup>The sum of n for a variable may not equal the total Group N due to missing values.

males were 1.35 times more likely than females to report having a handgun in the home, and those living on a farm were 1.70 times more likely to report a handgun than those residing in a town. No differences were seen by race/ ethnicity.

### Firearm Storage Practices in the Home

Among those aware of rifle/shotgun storage practices in their homes, almost one-third reported they were stored sometimes or always loaded, and over one-half reported they

**Table 3.** Bivariate and multivariable logistic regression analyses regarding the presence of handguns in the homes of adolescent survey respondents.

	Crosstab analysis			Logistic regression analysis	
	Yes n (Row %) <sup>b</sup>	No <sup>a</sup> n (Row %) <sup>b</sup>	P-value	Odds ratio	Confidence interval
Group N	580 (42%)	802 (58%)			
Gender			<i>P</i> = 0.005		
Male	430 (62%)	267 (38%)		1.35	1.08-1.68
Female	369 (54%)	311 (46%)		1.0 (ref)	
Age			<i>P</i> = 0.358		
16-18 years	516 (57%)	387 (43%)		0.88	0.77-1.11
13-15 years	286 (60%)	193 (40%)		1.0 (ref)	
Residence			<i>P</i> < 0.001		
Farm	458 (63%)	269 (37%)		1.70	1.32-2.18
Country/not a farm	143 (57%)	107 (43%)		1.30	0.95-1.80
Town	198 (50%)	202 (50%)		1.0 (ref)	
Race			<i>P</i> = 0.370		
White/Caucasian	769 (58%)	551 (42%)		1.0 (ref)	
Other races	32 (52%)	29 (48%)		0.90	0.53-1.52

<sup>a</sup>The actual response was “Not that I know of” as homes may have had firearms but the adolescent respondent may not have known that they were present.

<sup>b</sup>The sum of n for a variable may not equal the total Group N due to missing values.

were stored sometimes or always unlocked (Table 4). Almost one-fifth reported the rifles/shotguns were stored both loaded and unlocked at least some of the time. Overall, only one-third of those with rifles/shotguns in their home indicated they were safely stored at all times, ie, always stored unloaded and locked.

As for adolescents aware of handgun storage in their home, two-fifths reported the handguns were stored loaded, nearly one-half reported they were stored unlocked, and over one-fourth reported they were stored both loaded and unlocked at least some of the time. Like rifles/shotguns, only about one-third of youth with handguns in their home reported they were always stored safely (unloaded and locked). Of respondents overall who were aware of how firearms were stored in their homes, over four-fifths (802/974, 82.3%) reported at least one firearm was stored either unlocked or loaded at least some of the time.

### Comparison of Rifle/Shotgun Storage in the Home

As compared to their peers, males, older adolescents, and Whites/Caucasians more frequently reported having at least sometimes unlocked rifles/shotguns in the home (Table 5). When comparing storage by residence location, the percentage reporting unlocked rifles/shotguns in their homes was in the following order: those living on farms > those living in the country/not on a farm > those living

**Table 4.** Storage of firearms and of handguns in the homes of adolescent survey respondents.

	Rifles/shotguns n (Col %) <sup>a</sup>	Handguns n (Col %) <sup>b</sup>
Stored loaded		
No	731 (69%)	472 (60%)
Yes, sometimes	219 (21%)	170 (21%)
Yes, always	112 (11%)	151 (19%)
Stored unlocked		
No	521 (47%)	400 (54%)
Yes, sometimes	337 (30%)	209 (28%)
Yes, always	251 (23%)	133 (18%)
Stored loaded and unlocked		
No	879 (82%)	539 (73%)
Yes, sometimes	136 (13%)	124 (17%)
Yes, always	58 (5%)	71 (10%)
Overall storage		
Safe storage <sup>c</sup>	360 (33%)	275 (37%)
Unsafe storage <sup>d</sup>	716 (67%)	463 (63%)

<sup>a</sup>Does not include those who had no rifles/shotguns in the home or were unsure of storage.

<sup>b</sup>Does not include those who had no handguns in the home or were unsure of storage.

<sup>c</sup>Firearms always stored unloaded and locked.

<sup>d</sup>Firearms stored at least sometimes loaded and/or unlocked.

in town, overall  $P < 0.001$ . Logistic regression analysis indicated that males were 1.8 times more likely than females, older teenagers were 1.3 times more likely than younger teenagers, and those living on a farm were 1.8 times more likely than those residing in town to report at least one rifle/shotgun always or sometimes stored unlocked in their homes. In contrast to results for unlocked rifles/shotguns, there were no significant demographic differences with respect to rifles/shotguns being stored loaded in the home.

### Comparison of Handgun Storage in the Home

Males had significantly higher percentages reporting handguns were loaded, unlocked, and both loaded and unlocked as compared to females (Table 6). For those living on a farm, a greater percentage also reported unlocked handguns than those living elsewhere,  $P < 0.001$ . Logistic regression analysis showed males were 1.6 times, 1.7 times, and 2.7 times more likely than females to report having handguns stored loaded, unlocked, and both loaded and unlocked, respectively. Those living on farms were 1.6 times more likely than those from towns to report an unlocked handgun at least some of the time.

### Ammunition Storage Practices

Trends were similar when analyzing storage of ammunition for both rifles/shotguns and handguns (Table 7). For those aware of rifle/shotgun ammunition storage in their homes, 28% said the ammunition was stored unlocked, 31% stated it was locked with the firearms, and 41% reported it was stored and locked separately from the firearms, ie, safely. Among those aware of handgun ammunition storage practices, 25% stated it was stored unlocked in the home, 36% that it was locked with the handguns, and 40% that it was stored and locked separately. Although there were a number of differences among variables and ammunition storage in the home, the only consistent finding was that those living on farms as compared to those living in towns were 1.9 and 1.8 times more likely to have unlocked rifle/shotgun and handgun ammunition, respectively. Those reporting firearms were stored at least sometimes unlocked in the home were significantly more likely to also report unlocked ammunition as compared to respondents in homes where firearms were always kept locked,  $P < 0.001$  for both rifles/shotguns and handguns.

### Presence of Firearms in the Homes Adolescents Visit

Eighty-five percent (1168/1382) of respondents reported visiting homes with firearms. These homes included those of family members (86%), friends (82%), neighbors (47%), and others (11%). Males had higher proportions than females (90%, 629/696 vs 79%, 537/680,  $P < 0.001$ ) and Whites/Caucasians had greater percentages than other races (85%, 1124/1320 vs. 70%, 43/61,  $P =$

**Table 5.** Bivariate and multivariable logistic regression analyses regarding the storage of rifles/shotguns in the homes of adolescent survey respondents.<sup>a</sup>

	Crosstab analysis		P-value	Logistic regression analysis	
	Yes <sup>b</sup> n (Row %) <sup>c</sup>	No n (Row %) <sup>c</sup>		Odds ratio	Confidence interval
<b>Stored loaded</b>					
Gender			<i>P</i> = 0.521		
Male	193 (32%)	411 (68%)		1.08	0.83-1.41
Female	137 (30%)	318 (70%)		1.0 (ref)	
Age			<i>P</i> = 0.618		
16-18 years	227 (32%)	490 (68%)		1.07	0.81-1.42
13-15 years	104 (30%)	241 (70%)		1.0 (ref)	
Residence			<i>P</i> = 0.607		
Farm	195 (32%)	415 (68%)		1.05	0.76-1.45
Country/not a farm	57 (28%)	145 (72%)		0.87	0.58-1.32
Town	77 (31%)	169 (69%)		1.0 (ref)	
Race			<i>P</i> = 0.966		
White/Caucasian	319 (31%)	717 (69%)		1.0 (ref)	
Other races	11 (31%)	24 (69%)		1.05	0.51-2.19
<b>Stored unlocked</b>					
Gender			<i>P</i> < 0.001		
Male	366 (60%)	247 (40%)		1.83	1.43-2.33
Female	221 (45%)	272 (55%)		1.0 (ref)	
Age			<i>P</i> = 0.014		
16-18 years	411 (56%)	328 (44%)		1.34	1.03-1.73
13-15 years	177 (48%)	193 (52%)		1.0 (ref)	
Residence			<i>P</i> < 0.001		
Farm	365 (57%)	271 (43%)		1.83	1.35-2.46
Country/not a farm	109 (51%)	103 (49%)		1.40	0.96-2.03
Town	112 (43%)	146 (57%)		1.0 (ref)	
Race			<i>P</i> = 0.030		
White/Caucasian	573 (54%)	496 (46%)		1.0 (ref)	
Other races	14 (36%)	25 (64%)		0.53	0.27-1.05
<b>Stored loaded and unlocked</b>					
Gender			<i>P</i> = 0.003		
Male	129 (21%)	480 (79%)		0.88	0.67-1.16
Female	65 (14%)	396 (86%)		1.0 (ref)	
Age			<i>P</i> = 0.017		
16-18 years	144 (20%)	574 (80%)		1.25	0.93-1.68
13-15 years	50 (14%)	305 (86%)		1.0 (ref)	
Residence			<i>P</i> = 0.063		
Farm	125 (20%)	487 (80%)		1.19	0.85-1.65
Country/not a farm	32 (15%)	175 (85%)		0.80	0.51-1.24
Town	36 (14%)	214 (86%)		1.0 (ref)	
Race			<i>P</i> = 0.630		
White/Caucasian	186 (18%)	848 (82%)		1.0 (ref)	
Other races	8 (21%)	30 (79%)		1.13	0.54-2.35

<sup>a</sup>Those who answered "Unsure" regarding firearm storage were not included in that analysis.

<sup>b</sup>Includes those who answered "Yes, Always" and "Yes, Sometimes."

<sup>c</sup>The sum of n for a variable may not equal the total Group N due to missing values.

0.002) with respect to having visited homes with firearms. There were no differences by survey participant age or residence location. In logistic regression analysis, males were 2.4 times more likely than females (95% CI, 1.77-

3.32) and other races were 60% less likely than Whites/Caucasians (95% CI, 0.24-0.79) to report having visited homes with firearms. The firearms in the homes they visited were similar to the firearms in their own homes

**Table 6.** Bivariate and multivariable logistic regression analyses regarding the storage of handguns in the homes of adolescent survey respondents.<sup>a</sup>

	Crosstab analysis		P -value	Logistic regression analysis	
	Yes <sup>b</sup> n (Row %) <sup>c</sup>	No n (Row %) <sup>c</sup>		Odds ratio	Confidence interval
<b>Stored loaded</b>					
Gender			<i>P</i> = 0.003		
Male	199 (48%)	218 (52%)		1.56	1.15-2.10
Female	119 (37%)	204 (63%)		1.0 (ref)	
Age			<i>P</i> = 0.246		
16-18 years	217 (45%)	268 (55%)		1.10	0.81-1.51
13-15 years	104 (40%)	154 (60%)		1.0 (ref)	
Residence			<i>P</i> = 0.607		
Farm	176 (41%)	253 (59%)		0.75	0.53-1.07
Country/not a farm	60 (44%)	76 (56%)		0.83	0.52-1.31
Town	84 (48%)	91 (52%)		1.0 (ref)	
Race			<i>P</i> = 0.554		
White/Caucasian	310 (43%)	403 (57%)		1.0 (ref)	
Other races	11 (38%)	18 (62%)		0.80	0.46-1.01
<b>Stored unlocked</b>					
Gender			<i>P</i> < 0.001		
Male	218 (52%)	199 (48%)		1.74	1.29-2.36
Female	122 (38%)	200 (62%)		1.0 (ref)	
Age			<i>P</i> = 0.046		
16-18 years	236 (49%)	248 (51%)		1.25	0.91-1.71
13-15 years	106 (41%)	153 (59%)		1.0 (ref)	
Residence			<i>P</i> < 0.001		
Farm	215 (51%)	201 (49%)		1.58	1.10-2.27
Country/not a farm	54 (39%)	83 (61%)		1.00	0.63-1.60
Town	71 (39%)	109 (61%)		1.0 (ref)	
Race			<i>P</i> = 0.070		
White/Caucasian	333 (47%)	378 (53%)		1.0 (ref)	
Other races	9 (30%)	21 (70%)		0.52	0.23-1.16
<b>Stored loaded and unlocked</b>					
Gender			<i>P</i> < 0.001		
Male	143 (34%)	274 (66%)		2.65	1.84-3.83
Female	50 (16%)	264 (84%)		1.0 (ref)	
Age			<i>P</i> = 0.048		
16-18 years	138 (29%)	339 (71%)		1.27	0.88-1.84
13-15 years	57 (22%)	200 (78%)		1.0 (ref)	
Residence			<i>P</i> = 0.063		
Farm	119 (29%)	297 (71%)		1.51	0.76-2.24
Country/not a farm	36 (26%)	103 (74%)		1.31	0.76-2.24
Town	38 (22%)	138 (78%)		1.0 (ref)	
Race			<i>P</i> = 0.759		
White/Caucasian	188 (27%)	516 (73%)		1.0 (ref)	
Other races	7 (24%)	22 (76%)		0.95	0.39-2.31

<sup>a</sup>Those who answered "Unsure" regarding firearm storage were not included in that analysis.

<sup>b</sup>Includes those who answered "Yes, Always" and "Yes, Sometimes."

<sup>c</sup>The sum of n for a variable may not equal the total Group N due to missing values.

overall with 69% of the homes having both rifles/shotguns and handguns, 16% had rifles/shotguns only, and 2% had handguns only. Twelve percent of participants were not sure of the types of firearms present.

## DISCUSSION

We surveyed adolescent FFA members living in a rural state to learn about firearm exposure and storage practices in their homes. In our study, the vast majority of adolescents lived

**Table 7.** Bivariate and multivariable logistic regression analyses regarding the storage of rifle/shotgun and handgun ammunition in the homes of adolescent survey respondents.<sup>a</sup>

	Crosstab analysis			P -value	Logistic regression analysis	
	Ammunition not locked n (Row %) <sup>b</sup>	Ammunition locked with firearms n (Row %) <sup>b</sup>	Ammunition locked separately n (Row %) <sup>b</sup>		Odds ratio	Confidence interval
<b>Rifle/shotgun ammunition storage</b>						
Group N	291 (28%)	319 (31%)	431 (41%)			
Gender				<i>P</i> = 0.148		
Male	178 (30%)	171 (28%)	253 (42%)		1.16	0.88-1.54
Female	112 (26%)	147 (34%)	177 (41%)		1.0 (ref)	
Age				<i>P</i> = 0.012		
16-18 years	216 (31%)	203 (29%)	283 (40%)		1.59	1.17-2.16
13-15 years	75 (22%)	116 (34%)	148 (44%)		1.0 (ref)	
Residence				<i>P</i> = 0.011		
Farm	181 (30%)	172 (29%)	247 (41%)		1.86	1.29-2.69
Country/not a farm	62 (32%)	60 (31%)	72 (37%)		2.03	1.30-3.16
Town	47 (19%)	86 (35%)	111 (45%)		1.0 (ref)	
Race				<i>P</i> = 0.299		
White/Caucasian	310 (31%)	413 (41%)	284 (28%)		1.0 (ref)	
Other races	8 (24%)	18 (55%)	7 (21%)		0.74	0.31-1.74
Unlocked rifles <sup>c</sup>				<i>P</i> < 0.001		
Yes	235 (43%)	133 (24%)	179 (33%)		Not in the Analysis	
No	52 (11%)	179 (38%)	241 (51%)			
<b>Handgun ammunition storage</b>						
Group N	176 (25%)	255 (36%)	282 (40%)			
Gender				<i>P</i> = 0.030		
Male	115 (28%)	136 (33%)	155 (38%)		1.93	1.38-2.71
Female	60 (20%)	117 (38%)	127 (42%)		1.0 (ref)	
Age				<i>P</i> = 0.111		
16-18 years	126 (27%)	158 (34%)	182 (29%)		1.31	0.92-1.86
13-15 years	50 (20%)	97 (39%)	100 (40%)		1.0 (ref)	
Residence				<i>P</i> = 0.318		
Farm	107 (26%)	136 (33%)	164 (40%)		1.75	1.17-2.64
Country/not a farm	33 (26%)	51 (40%)	44 (34%)		1.51	0.9-2.51
Town	35 (20%)	67 (38%)	73 (42%)		1.0 (ref)	
Race				<i>P</i> = 0.370		
White/Caucasian	245 (36%)	267 (39%)	171 (25%)		1.0 (ref)	
Other races	9 (31%)	15 (52%)	5 (17%)		0.69	0.27-1.78
Unlocked handguns <sup>c</sup>				<i>P</i> < 0.001		
Yes	121 (38%)	89 (28%)	110 (34%)		Not in the Analyses	
No	49 (13%)	157 (42%)	168 (45%)			

<sup>a</sup>Those who answered “Unsure” regarding firearm storage were not included in that analysis.

<sup>b</sup>The sum of n for a variable may not equal the total Group N due to missing values.

<sup>c</sup>Firearms stored at least sometimes unlocked.

in a home with a firearm, with 84% having at least one rifle/shotgun and over half having handguns. Only 15% in our study had no firearms in their home. In addition, over four-fifths of the adolescents reported visiting homes that contained a firearm. Significant proportions of both rifles/shotguns and handguns in survey respondents’ homes were stored loaded and/or unlocked

at least some of the time. In fact, among those aware of storage in their home, more than four-fifths reported having at least one firearm loaded and/or unlocked at least some of the time. Moreover, those with unlocked firearms had significantly greater proportions with unlocked ammunition as compared with homes where firearms were always kept locked.

### Characteristics of Firearms in the Home

The proportion of rural youth in our study who lived in a home with at least one firearm was twice that found in a national 2017 Pew Research Center survey of all Americans.<sup>19</sup> Similarly, eight Gallup polls from December 2012–October 2019 found that 37–43% of US homes had a firearm.<sup>20</sup> The higher proportion observed in our study is consistent with numerous studies showing more frequent gun ownership in rural as compared to urban residences.<sup>19,21–24</sup> It is also consistent with a study of 983 households in one rural Iowa county from 1994–1998 where two-thirds of residents reported at least one firearm.<sup>25</sup>

Although rifles/shotguns were more common, handguns were present in over one-half of the homes in our study. Several studies of firearm injuries and deaths seen at rural trauma centers have shown handguns to be the most common firearm used and the ones most frequently involved in fatal cases.<sup>26–28</sup> Our findings of rural homes having high handgun ownership is also consistent with other studies that have demonstrated a high prevalence of handgun carrying among rural youth.<sup>29,30</sup>

Firearms in the home varied significantly based on where the adolescent lived, with significantly higher rates seen for those living on a farm or in the country but not on a farm. Our results mirror what has been reported in surveys of adults with the highest rates of firearm ownership for those living in rural, followed by suburban, and then urban areas.<sup>19,31</sup> Hunting is likely a major contributor to the higher rates of rifle/shotgun presence in the homes of adolescents living on farms and in the country.<sup>31</sup> One study found only 2% of metropolitan residents hunted as compared to 18% in cities of <50,000 people.<sup>32</sup> In many rural areas, hunting is a part of the culture and receiving a rifle or shotgun as an adolescent is a rite of passage.<sup>33</sup>

Males in our study were significantly more likely than females to report having a firearm in their home. The basis for this difference remains unknown. However, other studies have shown that males, especially White/Caucasian males, are more likely to own and/or to have grown up in a home with firearms.<sup>19,31</sup> Additionally, adolescent males in rural areas are more likely to have engaged in recreational firearm use and to have expressed pro-gun sentiments than their female peers.<sup>19,34</sup> Boys are disproportionately affected by firearm mortality accounting for more than 80% of all pediatric firearm deaths.<sup>7</sup> The higher rate of home firearms we observed with males may potentially be a contributing factor to this gender-based difference.

### Firearm and Ammunition Storage

Unsafe storage of firearms in the homes of rural youth in our study was high. Among those aware of storage practices, the vast majority (82%) reported at least one firearm stored unsafely at least some of the time. A Washington state study reported nearly two-thirds of adult

respondents with firearms stated they were not all safely stored (eg, both locked and unloaded).<sup>35</sup> Additionally, we found higher percentages of handguns, as compared to rifles/shotguns, were reported as being stored loaded and unlocked. Consistent with this observation are studies showing that the primary reason Americans state they have a firearm is for protection, and that firearms kept for protection, handguns in particular, are often stored loaded and unlocked for quick access.<sup>36–37</sup> Unfortunately, unsafe storage practices increase the risk of unintentional and self-inflicted firearm injuries in children and adolescents as is illustrated by studies showing firearms in the home are much more likely to kill or injure a household member than to be used in self-defense.<sup>38,39</sup>

### Firearms in Homes Visited

Over four-fifths of adolescents (85%) visited homes, most typically of family members or friends, that contained a firearm. The majority had both rifles/shotguns and handguns. Visiting a home with a firearm can be dangerous especially for younger adolescents. In one study of youth 11–14 years of age, nearly 40% of unintentional firearm deaths happened at the home of a friend, which was a proportion higher than that reported for younger children.<sup>40</sup> The authors speculated that the difference may be accounted for by decreased adult supervision of adolescents as compared to younger children.<sup>40</sup>

### Societal Implications

The results of our study suggest that rural adolescents in our state are a very vulnerable population. Previous research has shown that firearm-related unintentional and self-inflicted injuries and hospitalizations are higher in rural than in urban areas<sup>15,16,27,41</sup> Similarly, rural youth are three times more likely to die by suicide as compared to their urban counterparts.<sup>16,42</sup> The greater presence of firearms in rural homes as well as the relatively high prevalence of improper storage likely contribute to the disproportionate rates of rural adolescent firearm-related injuries and suicides.

### Prevention

To protect children and adolescents, parents and caregivers must prevent unwanted access to firearms.<sup>11,43</sup> The safest option would be to remove the firearm from the home, but as seen in our study, rural adolescents have potential access to firearms in the homes of others as well. The second most effective prevention approach is safe storage practices, particularly in homes where youth live and visit. Thus, widespread education and interventional programs are critically needed regarding the safe storage of firearms and ammunition. Another critically important measure is the passage of universal child access prevention (CAP) laws to protect children equally across states and

to better ensure the safe storage of firearms in homes.<sup>5,44-51</sup> Enforcement of these laws that hold parents and other relevant adults accountable when children and adolescents access firearms in the home might provide a strong impetus for more widespread safe storage of ammunition and firearms.<sup>52,53</sup> Reducing child and adolescent firearm access in turn could decrease unintentional and self-inflicted pediatric firearm-related deaths and injuries.<sup>10,54</sup>

## LIMITATIONS

Limitations of our study include that it was conducted in a single Midwestern state with a primarily White/Caucasian population. Thus, our findings may not be generalizable to other states and non-White populations. Additionally, we used a convenience sampling of adolescent FFA members primarily from rural areas attending a state conference; therefore, results may not be representative of the entire state, particularly urban communities. However, the great majority of counties in the state were represented by subjects in the study. Data was self-reported and may be subject to recall bias and social desirability. With regard to social desirability, participants would probably have been more likely to report safe rather than unsafe storage practices. Factors decreasing the social desirability effect included the fact that the surveys were written, completed independently, and collected anonymously.

It is possible that some study participants' homes had firearms of which the youth were unaware. Thus, the overall proportion of homes with firearms may be higher than that reported. In addition, there were some survey respondents who were unsure of at least one of the three firearm storage questions including 12% (142/1156) of those with rifles/shotguns and 11% (92/801) with handguns. These responses were not included in Table 4 calculations. Similarly, some adolescents were unsure how ammunition was stored in the home (9% for rifle/shotgun and 10% for handguns). Females and younger teenagers had higher proportions unsure of firearm and ammunition storage.

## CONCLUSION

The vast majority of rural adolescents in this study lived in a home with a firearm and many reported firearms and ammunition were stored unsafely. The likelihood of having a firearm in the home varied significantly based upon where the adolescent lived with highest rates for those living on a farm. Rural families would benefit from education about the importance of safe storage of firearms and ammunition to limit unwanted child and adolescent access. Consideration of the unique cultural and social aspects of rural communities is necessary to develop effective injury prevention strategies for this setting. The implementation of strict and well-enforced universal childhood access prevention laws may be a critical step in protecting youth from firearm-related tragedies.

*Address for Correspondence:* Charles A. Jennissen, MD, University of Iowa Carver College of Medicine, Department of Emergency Medicine, 200 Hawkins Dr, Iowa City, IA 52242. Email: charles-jennissen@uiowa.edu.

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# The Power of an Active Shooter Simulation: Changing Ethical Beliefs

**Maria-Pamela Janairo, MD\***<sup>†</sup>

**Annemarie Marier Cardell, MD<sup>‡</sup>**

**Michael Lamberta, MD<sup>‡</sup>**

**Nubaha Elahi, MD<sup>§</sup>**

**Amish Aghera, MD<sup>‡</sup>**

\*State University of New York Downstate Medical Center, Department of Emergency Medicine, Brooklyn, New York

<sup>†</sup>Kings County Hospital Center, Department of Emergency Medicine, Brooklyn, New York

<sup>‡</sup>Maimonides Medical Center, Department of Emergency Medicine, Brooklyn, New York

<sup>§</sup>Osceola Regional Medical Center, Department of Emergency Medicine, Kissimmee, Florida

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**Introduction:** During a hospital-based active shooter (AS) event, clinicians may be forced to choose between saving themselves or their patients. The Hartford Consensus survey of clinicians and the public demonstrated mixed feelings on the role of doctors and nurses in these situations. Our objective was to evaluate the effect of simulation on ethical dilemmas during a hospital-based AS simulation. The objective was to determine whether a hospital-based AS event simulation and debrief would impact the ethical beliefs of emergency physicians relating to personal duty and risk.

**Methods:** Forty-eight emergency physicians and physicians-in-training participated in this cohort study based in an urban academic hospital. Simulation scenarios presented ethical dilemmas for participants (eg, they decided between running a code or hiding from a shooter). Surveys based upon the Hartford Consensus were completed before and after the simulation. Questions focused on preparedness and ethical duties of physicians to their patients during an AS incident. We evaluated differences using a chi-squared test.

**Results:** Preparedness for an AS event significantly improved after the simulation ( $P = 0.0001$ ). Pre-simulation, 56% of participants felt that doctors/nurses have a special duty like police to protect patients who cannot hide/run, and 20% reported that a provider should accept a very high/high level of personal risk to protect patients who cannot hide/run. This was similar to the findings of the Hartford Consensus. Interestingly, post-simulation, percentages decreased to 25% ( $P = 0.008$ ) and 5% ( $P = 0.041$ ), respectively.

**Conclusion:** Simulation training influenced ethical beliefs relating to the duty of emergency physicians during a hospital-based AS incident. In addition to traditional learning objectives, ethics should be another important design consideration for planning future simulations in this domain. [West J Emerg Med. 2021;22(4.1)86-93.]

## INTRODUCTION

An active shooter (AS), as defined by the Federal Bureau of Investigation (FBI), is one or more individuals actively engaged in killing or attempting to kill people in

a populated area. Active shooter incidents have more than doubled between 2011–2018, with 27 reported in 2018.<sup>1,2,3</sup> The Hartford Consensus was developed in an effort to address this growing issue, as well as to establish a national protocol

to enhance survivability from AS and intentional mass casualty events by supporting the “run, hide, fight” algorithm to mitigate risk.<sup>4</sup> Healthcare settings are uniquely vulnerable targets because patients may be unable to “run, hide, fight.” Making the decision to “run” creates an ethical dilemma for providers who have their own moral obligation not to abandon their patients. In a 2017 survey of the public and healthcare professionals, Jacobs and Burns found that both groups felt doctors and nurses had a special duty to protect patients similar to police officers and firefighters.<sup>5</sup>

Training healthcare providers how to respond to mass casualty incidents such as active shooters often involves active training exercises such as simulation. Outcomes of such training programs typically focus on improving knowledge and skills around the medical response to preserve life.<sup>6,7</sup> The benefit of simulation-based training (SBT), as compared to didactic-based education, is that it allows the learner to have more time hands-on and encourages active participation. When studied side by side, simulation-based education was perceived as more enjoyable by students,<sup>20</sup> and when teaching simulated patient emergencies, was found to generate superior team performance.<sup>21,22</sup> Additionally, previous studies have used simulation to successfully evaluate resident response to ethical dilemmas.<sup>23</sup>

For this study, we were interested in using simulation to understand the physician perspective regarding personal duty and safety during an AS event. We hypothesized that the SBT would provide a realistic AS experience and change the perception of emergency physicians with regard to personal risk and duty. The primary study objective was to determine how the ethical beliefs of physician duty and personal risk are affected by a SBT exercise grounded in the “run, hide, fight” approach. Secondary objectives included the effect of SBT on their overall level of risk and preparedness for an AS event.

## METHODS

### Study Design

This was a cohort study to determine the perceptions of physicians regarding AS events before and after a SBT exercise. Survey questions and response options mirrored those used by the Hartford Consensus.<sup>5</sup> The study was classified as “exempt” by the local institutional review board.

The SBT was an active, operations-based functional exercise in crisis management rather than a discussion-based approach. The goal of this approach was to create an experience to allow learners to reflect on their roles when confronted with an in-hospital AS. The operations-based format challenged participants to make quick decisions and to act definitively in their perceived roles during a crisis. Simulation scenarios were designed to replicate the tension that may occur for participants responding to an AS while actively engaged in patient care. During the post-simulation debriefing, facilitators reviewed the “run, hide, fight” protocol while encouraging learners to actively reflect on their beliefs regarding duty to patients and personal safety.

### *Population Health Research Capsule*

What do we already know about this issue?  
*During a hospital based active shooter (AS) event, clinicians may be forced to choose between saving themselves or their patients.*

What was the research question?  
*Can simulation based training impact the ethical beliefs of physicians relating to personal duty and risk?*

What was the major finding of the study?  
*Simulation training influenced ethical beliefs relating to the duty of physicians during an AS incident.*

How does this improve population health?  
*In addition to traditional learning objectives, simulation can impact ethical beliefs and educators should consider this when developing curriculum.*

### Study Setting and Sample

The study was conducted at a private, urban hospital in the Northeast with an annual census of 120,000 patients, and associated Accreditation Council for Graduate Medical Education-accredited three-year emergency medicine (EM) residency and pediatric EM (PEM) fellowship programs. Participants consisted of a convenience sample of available EM attendings, EM residents, PEM fellows, and rotating fourth-year medical students who were available for Wednesday conference. We also chose to include available students as they actively contribute as care providers as part of the holistic team in our clinical setting. The SBT exercise was conducted during typical time reserved for education (Wednesday conference), which is generally mandated for all residents and fellows. Trainees were given the opportunity to opt out a day in advance through private correspondence over email, given the potential threat to psychological safety from an active shooter SBT.

### Measurements

Participants completed surveys immediately before and after the completion of the SBT exercise. Survey questions closely mirrored those previously used by the Hartford Consensus, with minor adaptations to collect basic data and to specifically reference the clinical environments staffed by physicians working at the local institution. Detailed demographic data regarding race, gender, and age were not included in the survey design due to concerns that with a small cohort of colleagues it would lead to

identifiable responses. The final survey questions are presented in Table 1, and a copy of our final instrument as viewed by our respondents is in Appendix 1 as well as a copy of our survey results in Appendix 2.

Lastly, participants were sent a link to provide anonymous feedback on a rating scale from 1 to 5 on the actual SBT exercise related to the following: clarity of learning objectives; orientation to simulation environment; realism of simulation; relevance to practice; psychological safety; and effectiveness of debriefing. They were also afforded the opportunity to provide additional written feedback.

**Validity Evidence of Survey Tool**

The survey was adapted from the Hartford Consensus study by Jacobs and Burns wherein these authors worked with an independent research firm specializing in probability-based survey research design. The survey questions were copied verbatim for our population, with the only change specifying the name of the hospital and other venues where the subjects worked. In the pre-briefing the authors instructed participants to respond based on their own personal beliefs as there may not be one “correct” answer to these questions. There were no consequences to our participants in relation to how they responded to survey

questions with an opt-out option, which nobody chose. We did not measure the relationship of participant responses to other known variables as we were unaware of specific measures that would predictably relate to ethical beliefs.

**Simulation-based Training Design**

Reference material on best practices managing AS events was sent to all potential participants one week prior to the SBT exercise.<sup>8,9</sup> As part of standard curricular processes, trainees were assigned preparatory questions to answer in advance of the session to help prime them to successfully manage the event. Prior to the scenarios, participants underwent a pre-briefing that focused on their psychological safety and pushing their comfort levels, as well as addressing the basic assumptions in simulation.<sup>10</sup> Participants were again given an opportunity to opt out of the scenario at any time before or during the scenario. No participants chose to opt out prior to or during the scenario.

Four scenarios were run simultaneously in adjacent mock clinical rooms within the Center for Clinical Simulation at the local institution. Each scenario was designed by experienced simulation faculty to present an ethical dilemma to the participants on whether they should independently “run,

**Table 1.** Survey questions and response options.

1. Identification	PGY1, PGY2, PGY3, Fellow, Attending, Medical Student
2. Current level of risk for an active shooter at the hospital	Very High, High, Moderate, Low, Very Low
3. Current level of risk for an active shooter event at a hospital staffed event (Barclays, MSG, music festival, etc.)	Very High, High, Moderate, Low, Very Low
4. Current level of preparedness for an active shooter event at the hospital	Very Prepared, Somewhat Prepared, Not so Prepared, Not at all Prepared
5. Current level of preparedness for an active shooter event at a hospital staffed event (Barclays, MSG, music festival, etc.)	Very Prepared, Somewhat Prepared, Not so Prepared, Not at all Prepared
6. What is the importance of being prepared for an active shooter event at the hospital?	Extremely Important, Very Important, Somewhat Important, Not so Important, Not at all Important
7. What is the importance of being prepared for an active shooter event at a hospital staffed event (Barclays, MSG, music festival, etc.)	Extremely Important, Very Important, Somewhat Important, Not so Important, Not at all Important
8. Do doctors and nurses have a special duty like police officers and firefighters to protect patients who cannot get out of harm’s way from an active shooter?	Special duty, Beyond their duty
9. If you answered special duty, how strongly do you feel?	Strongly, Somewhat Strongly
10. What is the level of personal risk doctors and nurses should accept to protect patients who cannot get out of harm’s way?	Very High Risk, High Risk, Moderate Risk, Low Risk, None
11. If you were a patient unable to get out of harm’s way, would you expect doctors and nurses to put themselves at risk to protect you?	Y, N
12. Should doctors and nurses be required to try to save the lives of patients in an active shooter attack or should this be a personal choice?	Required, Personal Choice
13. Have you been a patient in a hospital?	Y, N
14. How long ago was the last time you were a patient in a hospital?	Past 12 months, >1 year ago but <5 years ago, >5 years ago
15. Have you ever stayed overnight as a patient in a hospital?	Y, N

\*All questions provided a “No Opinion” answer choice.

PGY, postgraduate year; MSG, Madison Square Garden; Y, Yes; N, No.

hide, fight” vs co-manage patients (Table 2). The scenarios were designed to specifically address an ethical dilemma complicating the participants’ abilities to run, hide or fight. A total of five trainees were present in each room, as well as two faculty members whose responsibility was to role-play within the scenario and to push the trainees to make difficult decisions while ensuring their psychological safety. Faculty members used their roles to prompt trainees to make difficult decisions regarding prioritizing patient care vs prioritizing personal safety as the simulation evolved. This is one of the benefits of SBT: Faculty can adjust the script in real time to engage quiet participants, foster debate, and encourage discussion about team priorities.

The simulation started with a recording of gunshots played from a portable speaker located in the hallway outside the respective scenario rooms. To generate ambiance during the scenario the portable speaker was moved up and down the hallway and periodic additional “gunshots” were fired. A group debriefing followed to address the various reactions that arose in response to various ethical dilemmas. This debriefing also emphasized the “run, hide, fight” algorithm and broke down scenarios specific to our ED and affiliated venues on where to hide or run if ever faced with this situation. The total

length of the session was approximately 90 minutes and was repeated for a second group of learners.

**Data Analysis**

Survey responses were presented using descriptive statistics. We evaluated differences in responses before and after the SBT using a chi-squared test. A P value of <0.05 was considered statistically significant. We used SPSS version 24 (IBM Corp., Armonk, NY) to analyze the data.

**RESULTS**

Forty-eight emergency physicians and physicians-in-training participated in the SBT exercise (15 postgraduate year [PGY]1 EM residents, 7 PGY2 EM residents, 10 PGY3 EM residents, 5 PEM fellows, 8 EM attendings, and 3 medical students). Three EM faculty participants with prior knowledge of the Hartford Consensus survey and implicit knowledge of the study design were excluded from completing the survey as they would not be able to answer questions without inherent bias. Of the remaining 45 participants, 44 completed a pre-simulation survey (98% of participants) while 45 completed a post-simulation survey (100% participation). None of the participants chose to opt out of the simulation training because of a preexisting threat to

**Table 2.** Brief descriptions of simulation scenarios including primary patient diagnosis, role of embedded participants, resources needed, and pertinent ethical dilemma.

	Scenario description	Patient: primary diagnosis	Role of embedded participant(s)	Resources needed	Ethical dilemma
Case 1	Run a witnessed cardiac arrest with a reversible cause.	Hyperkalemia from acute onset renal failure	Nurse	High fidelity mannequin with operator. Embedded simulation participant to play role of nurse	How do you prioritize the needs of a patient that may be able to be saved under different circumstances?
Case 2	Manage a patient with an acute stroke eligible for thrombolysis with actively concerned family at the bedside.	Acute stroke	Family Member and Patient	Embedded simulation participants to play roles of patient and family member.	How to prioritize the needs of a non-ambulatory patient with a treatable condition?
Case 3	Manage an acute ST- elevation myocardial infarction (STEMI) requiring percutaneous angiography.	STEMI	Patient and Nurse	Embedded simulation participants to play roles of patient and nurse	How do you care for a patient with a treatable condition during an MCI?
Case 4	Manage a non-ambulatory patient with knee pain while a wounded physician attempts to run into the examination room.	Fractured knee and GSW complicated by PTX.	Patient and injured staff member.	Embedded simulation participants to play roles of patient and injured staff	How do you prioritize the needs of an injured colleague?

MCI, mass-casualty incident; GSW, gunshot wound; PTX, pneumothorax.

psychological safety. Of the 45 participants, 27% had previously been a patient who stayed overnight in a hospital: 12% in the prior 12 months; 29% between 1-5 years in the past, and 59% over five years in the past.

A perceived high or very high risk of an AS did not significantly change after the SBT. The perceived level of preparedness and the importance of being prepared did significantly increase after the SBT. The level of importance to be prepared for an AS event was high before and after the SBT. Specific results are summarized in Table 3 and 4.

Participants feeling that doctors and nurses have a special duty like police officers and firefighters to protect patients who cannot get out of harm's way from an AS significantly decreased from 60% to 25% ( $P = 0.008$ ). Of those who answered that physicians/nurses have a special duty, 32% felt strongly prior to the simulation, while 11% expressed this after the simulation ( $P = 0.243$ ).

The ethical belief relating to a high or very high level of personal risk that doctors and nurses should accept to protect patients who could not get out of harm's way decreased significantly from 21% to 5% ( $P = 0.041$ ). If participants themselves were patients who were unable to get out of harm's way, 98% expressed no opinion in regard to expectations of doctors/nurses to get them out of harm's way. After the simulation, 100% expressed no opinion on the survey ( $P = 0.309$ ). Similarly, participants expressed no opinion (100%) regarding whether doctors or nurses should be required to save the lives of patients during a hospital-based AS event. After the simulation, the results remained unchanged (100%), where participants had no opinion.

Anonymous feedback on the SBT was provided by 31 participants (69% response rate) and is summarized in Table 5. Written feedback about realism ranged from "failed to make me feel truly threatened" to "it gave me anxiety and palpitations."

## DISCUSSION

The perceived level of risk of an AS incident within a hospital setting compared to a more public setting (ie, concert hall, stadium, etc.) in our study was consistent with the FBI study.<sup>1,2</sup> Public spaces were seen as a greater risk than hospital settings. The overwhelming majority believed in the importance of being prepared for such an event in a hospital or hospital-staffed setting. This again stresses the importance of keeping a safe environment for vulnerable populations in a hospital setting, and the need for formal, AS training exercises.

The Office of the Assistant Secretary for Preparedness and Response, part of the Department of Health and Human Services, produced a comprehensive report to guide planning for an AS event in healthcare settings.<sup>11,12</sup> The report recommends mental rehearsal to work through various response options, which leads to better preparation. Simulation-based drills take this a step further, creating scenarios in which healthcare workers can work through ethical dilemmas and practice the "run, hide, fight" algorithm.

Our results support the perception that preparedness does in fact improve after SBT. One prior study did demonstrate that knowledge around active shooters improved after training, albeit with a significantly more elaborate and time-intensive curricular design on a military base.<sup>7</sup> While our study did not explicitly test knowledge gains, the curricular design was significantly more feasible and replicable for any hospital with modest space and equipment resources. In fact, written feedback about the realism of our relatively low-fidelity simulation suggests that it was more than adequate for some learners. A potentially more relevant next step in evaluating the impact of active drills would be to study actual performance during in situ drills after SBT.

The findings show that most participants, prior to this intervention, perceived a duty to protect their patients during an AS scenario and were willing to accept a high level of personal risk to do so. They also demonstrate that AS simulations are an effective way to challenge this perception, reducing its prevalence among participants. Interestingly, pre-survey responses in our cohort were similar to health professional responses to the Hartford Consensus survey. They found 62% believed they had a special duty to protect patients, and 27% felt they should accept a high or very high degree of risk to help patients unable to get out of harm's way. Post-survey responses demonstrated a significantly decreased sense of duty after SBT. We suspect that this relates to the experiential nature of simulation to provoke physical and emotional responses.<sup>13,14</sup> These responses serve as the basis for changing learner frames after simulation.<sup>13,14</sup>

The debriefing of this SBT was rather open ended and focused on the "run, hide, fight" paradigm. During the debriefing the participants were asked about familiarity with the Hartford Consensus, and while there was some basic knowledge of its existence no participant identified as having an understanding of the consensus results. During the reflective process, some participants remained quite adamant that they would not be able to live with themselves if they did not do their best to protect their patients, while others opined that it was necessary to survive to be able to help manage victims and future patients. Others still expressed that they would help as many patients as possible within the limits of their personal safety. Ultimately, the degree of personal risk that a physician/nurse accepts is a choice. The SBT seemed to give our participants an opportunity to make an informed decision that they could be comfortable with if they were to have the unfortunate experience of needing to deal with the ramifications of those decisions from an actual AS event.

Ethics has traditionally been inadequately addressed in medical education.<sup>15</sup> Prior reviews of teaching and assessment of ethics in undergraduate medical education (UME) found that students, deans, and course directors wished for it to be better integrated with their coursework.<sup>16,17</sup> A key feature of SBT is that it is experiential, which allows for theoretical aspects of ethics to become more concrete. As compared to SBT, traditional

education using didactics is mostly a passive experience for the learner. Simulation allows for active engagement and has several features that make it well suited for AS training in ways that are not feasible with a traditional classroom format. Simulation allows for feedback grounded in individual and team performance.<sup>24</sup> Furthermore, SBT is adaptable to the needs of the learner based on their performance.

Embedded facilitators within a scenario can interact with participants allowing for an experience that will address the learning objectives regardless of their baseline knowledge or their ability to interact within the simulation.<sup>25</sup> Using a simulated context allows facilitators to leverage principles of adult learning theory grounded in the belief that education is learner-centric, in stark contrast to didactic-based education

**Table 3.** Summary results by training year for key questions.

	PRE	PRE	POST	POST	% Change (post – pre)	
	% H & VH	% L & VL	% H & VH	% L & VL	% H & VH	% L & VL
What is the level of risk at Maimonides Hospital?	18%	48%	24%	36%	6%	-12%
PGY1	14%	57%	13%	33%	-1%	-24%
PGY2	11%	56%	14%	86%	3%	30%
PGY3	33%	33%	30%	20%	-3%	-13%
PEM fellow	0%	40%	40%	0%	40%	-40%
Med student	0%	100%	33%	67%	33%	-33%
Attending	40%	20%	40%	20%	0%	0%
	% H & VH	% L & VL	% H & VH	% L & VL	% H & VH	% L & VL
What is the current level of preparedness at Maimonides?	7%	23%	53%	9%	47%	-14%
PGY1	7%	43%	33%	27%	26%	-16%
PGY2	11%	0%	57%	0%	46%	0%
PGY3	11%	0%	80%	0%	69%	0%
PEM fellow	0%	20%	60%	0%	60%	-20%
Med student	0%	0%	67%	0%	67%	0%
Attending	0%	60%	40%	0%	40%	-60%
	% SD	% BD	% SD	% BD	% SD	% BD
Do doctors and nurses have a special duty like police officers to protect patients?	45%	36%	20%	60%	-25%	24%
PGY1	43%	36%	20%	53%	-23%	18%
PGY2	57%	43%	14%	86%	-43%	43%
PGY3	67%	33%	30%	70%	-37%	37%
PEM fellow	20%	20%	20%	20%	0%	0%
Med student	50%	0%	0%	67%	-50%	67%
Attending	20%	60%	20%	60%	0%	0%
	% H & VH	% L & VL	% H & VH	% L & VL	% H & VH	% L & VL
What is the level of personal risk doctors should accept to protect patients who can't get out of harm's way?	17%	33%	4%	53%	-12%	20%
PGY1	21%	36%	0%	53%	-21%	18%
PGY2	29%	14%	14%	43%	-14%	29%
PGY3	11%	44%	0%	60%	-11%	16%
PEM fellow	0%	60%	0%	80%	0%	20%
Med student	0%	0%	0%	33%	0%	33%
Attending	20%	20%	20%	40%	0%	20%

VH, very high; H, high; M, moderate; L, low; VL, very low; SD, special duty; BD, beyond their duty; PGY, postgraduate year; PEM, pediatric emergency medicine.

**Table 4.** Pre- and post-survey results: perceived risk by location, current level of preparedness by location, and the importance of each location being prepared for active shooter events.

Location (question)	Pre-survey	Post-survey	P-value
Hospital (high or very high risk)	9%	13%	0.490
Hospital-staffed Public Event (high or very high risk)	17%	28%	0.181
Hospital (very prepared or somewhat prepared)	7%	57%	0.0001
Hospital-staffed Public Event (very prepared or somewhat prepared)	23%	76%	0.0001
Hospital (extremely or very important to be prepared)	88%	89%	0.326
Hospital-staffed Public Event (extremely or very important to be prepared)	100%	96%	0.329

which is educator-centric.<sup>26</sup> Also, the ability to fully control the environment is important as educators can titrate the appropriate level of “stress” for the learner without putting them in actual danger.<sup>24</sup> It is because of these benefits that we chose to use simulation to address our educational goals. In our review of the literature regarding the education of ethics in UME, we found that educators should provide “a set of skills for ethical analysis and decision making.”<sup>18</sup> The fact that beliefs were altered after SBT suggests that this was an effective method for discussing ethics while simultaneously providing a practical framework to apply lessons AS events, it may also be useful to study other paradigms when “run, hide, fight” may not be feasible. Inaba and colleagues proposed an alternative of “secure, preserve, fight.”<sup>19</sup> Training to this mantra using simulation may also serve to further aid healthcare professionals’ ability to protect themselves while still satisfying their duty to the patient.

## LIMITATIONS

This study was based out of a single, urban, academic EM program focusing on physicians, and thus its generalizability may be limited. This population may not reflect that of other programs. As with all observational studies, there is potential for confounders not predicted or identified by the authors. Additionally, as a simulation-based exercise the experience is highly dependent on facilitator experience leading to questions of generalizability. While a growing body of evidence supports that skills learned in the simulation laboratory do

**Table 5.** Anonymous participant scenario feedback on a scale of 1 (poor) to 5 (excellent).

Question	Mean rating
Clearly conveyed simulation objectives?	4.8
Orientation to learning environment?	4.8
Relevance to clinical practice?	4.3
How safe did you feel during the scenario?	4.5
Was the realism sufficient for the exercise?	3.8
Quality of debriefing to promote a dialog that enhanced knowledge, reflection, and provide clear/constructive feedback?	4.8

1= No/Poor or Not at All; 5= Yes/Excellent, or Extremely.

translate to practice, it is difficult to predict how quickly skills or practices decay without additional primers. Given that EM providers in particular are placed in a unique social and clinical setting, they are more likely to be prone to workplace violence, which might further impact how they perceive their ethical responsibilities over time. This study did not follow participants longitudinally for the stability of the change in their ethical beliefs. Additionally, we were unable to determine whether there was any hidden facilitator bias during the debrief in shaping the impact of the SBT. Lastly, compared to many mass casualty simulations, this SBT was relatively low fidelity and resource intensive, which may have blunted its potential impact for those participants who had difficulty immersing themselves in the scenario.

## CONCLUSION

Active planning and training for an active shooter event is critical. During a hospital-based AS event, clinicians may be forced to choose between saving themselves or their patients. The study demonstrates that simulation training can influence ethical beliefs relating to the duty of doctors and nurses during a hospital-based AS incident. This underscores the power of simulation to significantly impact learners, including relatively low-resource designs such as ours. In addition to traditional learning objectives, ethics should be another important design consideration for planning future simulations in this domain.

*Address for Correspondence:* Annemarie Cardell, Center for Clinical Simulation, 948 48th St., 4th floor, Brooklyn, NY 11219. Email: [acardell@maimonidesmed.org](mailto:acardell@maimonidesmed.org).

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# Self-Inflicted Gun Shot Wounds: A Retrospective, Observational Study of U.S. Trauma Centers

Faith Quenzer, DO\*

Andrew Givner, MD†

Rachel Dirks, PhD‡

Christopher J. Coyne, MD, MPH\*

Frank Ercoli, MD†§

Ricard Townsend, MD†§

\*University of California, San Diego, Department of Emergency Medicine, San Diego, California

†Desert Regional Medical Center, Department of Emergency Medicine, Palm Springs, California

‡University of California, San Francisco-Fresno, Department of Emergency Medicine, Fresno, California

§Desert Regional Medical Center, Desert Trauma Surgeons, Palm Springs, California

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**Introduction:** Intentional self-harm (suicide) by firearms is a growing problem in the United States. Currently, there are no large studies that have identified risk factors for patients who die from self-inflicted gunshot wounds. Our objectives are to 1) identify risk factors for patients with the highest morbidity and mortality from self-inflicted gunshot wounds (SIGSWs) at trauma centers 2) present the outcomes of victims of SIGSW by handguns (HG) versus all other specified guns (AOG) and 3) compare the presentations and outcomes of victims with head or face (HF) injuries to other regions of the body.

**Methods:** We performed a retrospective analysis from the National Trauma Database (NTDB) data between 2012 and 2013 of all SIGSW patients who presented to trauma centers. Categorical data included patient characteristics upon presentation and outcomes which were compared between patients with HG injury versus AOG injury using the Chi-Squared test, where AOG includes shotguns, hunting rifles, and military firearms. Additionally, analysis of head and face (HF) injuries versus other bodily injuries (OBI) were compared between the HG group versus AOG group using Chi-squared test.

**Results:** There were 7,828 SIGSWs, of those, 78% (6,115) were white and 84.3% (6,600) were male. There were 5,139 HG injuries, 1,130 AOG injuries, and 1,405 unidentified gun injuries. The HG group was likely to be older (>55 years old), hypotensive (systolic blood pressure < 90), have a lower Glasgow Coma Score (GCS < 9), use illegal, or use prescription drugs. In comparing HF injuries (4,799) versus other bodily injuries (OBI) (3,028), HF group was more likely to use handguns, expire in ED, require ICU, and have a higher percent of overall mortality. Of the total OBI, the thorax, upper extremities, and abdomen were the most commonly injured.

**Conclusion:** In our retrospective study of SIGSWs, we were able to demonstrate that SIGSW by handguns are associated with higher rates of mortality versus all other types of firearms. SIGSWs in older white males with handguns are the most at-risk for severe complications. Future efforts should improve screening methods for handguns in suicidal patients and at developing prevention programs. [West J Emerg Med. 2021;22(4.1):94-100.]

## INTRODUCTION

Intentional self-harm (suicide) is a growing problem in the

United States (U.S.) and has recently become one of the top ten leading causes of death. Earlier studies have shown that higher

rates of firearm ownership are strongly associated with higher rates of firearm suicide.<sup>1-2</sup> We designed this study to investigate several characteristics surrounding self-inflicted gunshot wounds (SIGSWs) that present to designated trauma centers.

According to the most recent data in 2017, a total of 39,773 deaths were due to firearms, which has increased since the previous year. Reportedly, 60% of these firearm arm deaths were self-inflicted. Whereas, firearm deaths due to assault accounted for 36.6%. Despite the fact that a majority of firearm deaths were self-inflicted, there is still a limited amount of research and data on self-inflicted firearm deaths and injury.<sup>1-3</sup> Additionally, self-inflicted gunshot wounds are not always clearly defined as intentional, as in suicide. For the purpose of our study, self-inflicted gunshot wound (SIGSW) is defined as a gunshot wound while the gun was in the possession of the injured person at the time of firing, with an unknown intent of the shooter. Conversely, assault by gunshot wound will be defined as when the gun was not in the possession of the injured person at the time of firing.

Our objective is to compare the presentations and outcomes of victims of self-inflicted gunshot wounds (SIGSW) by handguns (HG) versus all other specified guns (AOG) group. Additionally, we compare the presentations and outcomes of victims with head or facial (HF) injuries to those with injuries to other regions of the body.

## METHODS

We performed a retrospective analysis of data, which was taken from the National Trauma Database (NTDB). This data represents all patients of all ages who presented to designated trauma centers in the United States (U.S.) between 2012 and 2013. The data were extracted from various external cause of injury codes (e-codes). These e-codes were diagnosis codes to explain the circumstances and the external causes of a particular injury prior to the use *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) codes. Patients who presented to designated U.S. trauma centers with e-codes 955.0 (Suicide and self-inflicted injury by handguns), 955.1 (Suicide and self-inflicted injury by shotgun), 955.2 (Suicide and self-inflicted injury by hunting rifle), and 955.3 (Suicide and self-inflicted injury by military firearm) were included in the analysis. From the e-codes, patient demographics, characteristics, and outcomes were analyzed by using contingency tables and the Chi-Square test. We compared the characteristics and presentations of those who sustained a HG injury versus AOG. Any firearm that was not a HG was an AOG. These AOGs include shotguns, hunting rifles, and military firearms. Additionally, a subgroup analysis was performed which compared head and face (HF) injuries versus other bodily injuries (OBI) using the Chi-squared test.

## RESULTS

From the National Trauma Database (NTDB), a total of 7,828 cases of SIGSWs presented at designated U.S. trauma centers from 2012 to 2013. Of these SIGSWs, there 5,139 HG

### *Population Health Research Capsule*

What do we already know about this issue?  
*Suicide by firearms is a growing problem in the U.S.*

What was the research question?  
*What factors increase the morbidity and mortality of self-inflicted gunshot wounds (SIGSWs) at trauma centers?*

What was the major finding of the study?  
*Handguns are associated with higher morbidity and mortality in SIGSWs in older white males.*

How does this improve population health?  
*Our study highlights the need to screen suicidal patients with firearm access in the emergency department.*

injuries and 1,130 AOG injuries. The raw data show that males accounted for 6,600 (84.3%) patients and females accounted for 1,228 (15.7%) patients. Of the total number of SIGSWs, 6,115 (78%) were identified as White. There were 1,405 SIGSWs that were excluded from the analysis because the data did not identify the type of firearm involved. Additionally, 154 patients whose injuries may not have been a SIGSW were excluded from analysis.

In comparing the two SIGSW groups; patients who sustained HG injuries were more severely injured compared to AOG injuries. As observed in Table 1, patients in the younger than 55-year-old age group who sustained SIGWS were more likely to use all other guns (shotguns, hunting rifle, military firearms). The HG group was more likely to be older than 55 years of age ( $p < 0.001$ ), male ( $p = 0.001$ ), and hypotensive with systolic blood pressure less than 90 mmHg ( $p < 0.001$ ). The HG group was also more likely to have a Glasgow Coma Score (GCS) less than 9 ( $p < 0.001$ ). In those with a GCS total of 9 to 13, there was no statistical difference between the HG and the AOG groups. However, the AOG patients were more likely to have a GCS of 14 or 15 (51%) versus the HG group (39%) with  $p < 0.001$ .

There was no difference between the proportion of those who tested positively for alcohol intoxication in the HG versus AOG groups ( $p = 0.25$ ). The 1,581 (49%) patients in the HG group and 367 (51%) patients in the AOG group tested positively for alcohol. Only a limited number of patients received toxicology panels: 2,013 of the HG group and 438 of the AOG group. Among these groups, the HG group had a higher proportion of patients who tested positively for illicit drugs versus 740 (37%) versus the AOG group 129 (30%) ( $p=0.004$ ). While interestingly,

the AOG group had a higher proportion of who tested positively for prescription drugs with 212 (48%) versus the HG group with 719 (36%),  $p < 0.001$ .

In examining SIGSW bodily injuries, head or facial (HF) injuries were more lethal and presented with severe morbidity compared to other bodily injuries (OBI) in the ED. In Table 2, of the 4,799 HF injuries, 1,052 (22%) resulted death in the ED versus the 111 (4%) of the 3,028 OBI patients ( $p < 0.001$ ). Of the HF injured patients, 2,768 (58%) required ICU care versus 531 (18%) of the OBI patients ( $p < 0.001$ ). Those with OBI injuries were more frequently admitted to the hospital floor 660 (22%), taken to the OR 1,303 (43%), or discharged home versus their HF injured counterparts with  $p < 0.001$ . Of the HF injured patients, 2,817/4,799 (59%) died during their presentation to the ED versus 365/3,048 (12%) of the OBI patients ( $p < 0.001$ ).

The categorization of the 2012 to 2013 NTDB data follows a trimodal model supported by earlier trauma where severity of injury is categorized trauma associated mortality.<sup>4</sup> Immediate death or dead-on-arrival (DOA) occurs within minutes to within an hour of arrival at the hospital. These patients are likely to have sustained unsurvivable injuries. Additionally, patients who die within the four-hour interval are also likely to have sustained serious, severe injuries but will take into account for regional transport time from the trauma scene and to the hospital trauma center.<sup>4</sup> Those who die within the 4-to-24-hour time frame also have but are considered to have been potentially treatable with prompt definitive care.<sup>4,5</sup> Those who die within the 24–72-hour timeframe also has treatable injuries, but likely die from complications of the inciting trauma.<sup>4</sup> Those who die outside of the 72-hour time frame, likely die from a complication other than the trauma itself such as pulmonary embolisms.<sup>6</sup>

We compared several time of death intervals between the HF and OBI groups. There was no statistically significant difference between those who presented DOA to the ED between the two groups. In the OBI group, a greater proportion died within four hours of arrival and in the greater than 72 hours versus the HG group ( $p < 0.001$ ). A greater proportion of the HG group died within the 4-24 hour time frame and the 24-72 hour time frame than the AOG group ( $p < 0.001$ ).

In the subgroup analysis of the 3,028 OBI, the most common region of the body injured was the thorax 1,261 (42%), followed by 924 (30%) upper extremity injuries, 885 (29%) abdominal injuries, and 783 (26%) lower extremity injuries. There were only 118 (4%) SIGSW patients who presented with spinal injuries. In those categorized with HF injuries in the ED, 252 (5%) presented with neck injuries versus OBI with 114 (4%) ( $p = 0.002$ ).

## DISCUSSION

The United States (U.S.) has one of the highest rates of overall firearm associated mortality when compared to other developed, high-income countries.<sup>7,8</sup> Most firearm-related injuries and deaths in the U.S. are actually due to suicides and self-inflicted gunshot wounds.<sup>1,9</sup> The rate of firearm associated suicides is 8 times higher in the U.S. when compared to other high-income countries such as Canada and South Korea.<sup>2</sup> Over the recent decade, the number of suicides has been steadily increasing and is now one of the top 10 leading causes of death in the U.S.<sup>9</sup> Prior studies have demonstrated that firearm ownership has had a strong association with suicide and intentional self-harm.<sup>10-14</sup>

Self-inflicted firearm injury as a form of attempted suicide is

**Table 1.** Comparison of the handgun group vs all other specified gun group (AOG).

Demographics	Handgun (N = 5,139)	All other specified gun (N = 1,130)	P-value
Age			
0-15	78 (2%)	34 (3%)	0.001
16-55	3,821 (74%)	888 (79%)	0.002
>55	1,221 (24%)	202 (18%)	<0.001
Male gender	4,141 (81%)	960 (85%)	0.001
SBP* < 90	1,131 (22%)	190 (17%)	<0.001
Glasgow Coma Scale			
< 9	2,726 (53%)	454 (40%)	<0.001
9-13	209 (4%)	48 (4%)	0.75
14-15	1,986 (39%)	573 (51%)	<0.001
Alcohol present	1,581/3,243 tested (49%)	367/718 tested (51%)	0.25
Drug use**	(2013 tested)	(438 tested)	
No drugs	687 (34%)	150 (34%)	0.96
Illicit drugs	740 (37%)	129 (30%)	0.004
Prescription drugs	719 (36%)	212 (48%)	<0.001

\*SBP is systolic blood pressure in millimeters mercury (mmHg) recorded upon hospital arrival.

\*\*Drug use (percent to exceed 100 because many have tested positively to both prescription and illegal drugs).

more lethal in contrast to other forms of self-inflicted penetrating injury.<sup>6,11-17</sup> In spite of the rising rate of attempted suicide and self-inflicted firearm deaths, there has been limited funding to support the research of gun violence. Therefore, it remains difficult to understand the factors and characteristics that contribute to gun violence and suicide.<sup>18-19</sup>

Gun ownership is very prevalent in the United States with a population that has the greatest number of civilian-held firearms in the world. It is estimated that there are 265,000,000 to 393,347,000 firearms held by civilians in the United States.<sup>18,19</sup> A recent 2020 poll estimates that 32% of Americans possess a firearm and that 44% live in a households with at least one firearm.<sup>20</sup>

Out of all the firearms that are manufactured and bought in the United States, the handgun is the most popular and most often purchased.<sup>18,19</sup> Overall, firearm ownership has been associated with an increased risk of violent death.<sup>10-14, 21, 23</sup> Handgun ownership, in particular, appears to be associated with an increased risk of suicide.<sup>10-11, 21, 22</sup> A recent study demonstrates that rates of suicide by any method were higher among handgun owners when compared to non-owners.<sup>18</sup> A study of suicides

in California demonstrated that within the first week after the purchase of a handgun, the rate of suicide among purchasers (644 per 100,000 person-years) was 57 times higher than the adjusted rate of suicide in the general population.<sup>3</sup> Even in the five years after the legal purchase of a handgun, there is an associated increased risk of suicide.<sup>21</sup>

Similar to previous studies, we found that SIGSW by handgun was associated with increased risk of death and high morbidity when compared to SIGSWs by other gun types. Older, white males with handguns comprise of the highest proportion of suicide by firearm.<sup>10,13,14</sup> Prior smaller studies have demonstrated that serious head injuries are often caused by handgun SIGSWs.<sup>14, 24-26</sup> A more recent study revealed that SIGSW head and facial injuries had a high survivability, but only in the absence of significant neurological injury.<sup>26</sup> Those with a GCS 14 -15 were likely to have little or no associated brain injury and their wounds were localized to the face. However, SIGSWs that result in brain trauma are significantly associated with mortality.<sup>24-26</sup>

Prior to this study, there has been no large, multi-center retrospective analysis on self-inflicted gunshot wound victims

**Table 2.** Outcomes of head and facial injuries versus those with other body injuries excluding head and face.

	Head or facial injury (N = 4,799)	Other bodily injuries (N = 3,028)	P-value
<b>ED disposition</b>			
Death	1,052 (22%)	111 (4%)	<0.001
ICU	2,768 (58%)	531 (18%)	<0.001
Floor	181 (4%)	660 (22%)	<0.001
OR	536 (11%)	1,303 (43%)	<0.001
Home	107 (2%)	287 (9%)	<0.001
Mortality	2,817 (59%)	365 (12%)	<0.001
<b>Time to death</b>			
DOA (<10 min LOS)	379 (14%)	50 (14%)	0.90
<4 hrs	801 (28%)	213 (58%)	<0.001
4-24 hrs	907 (32%)	38 (10%)	<0.001
24-72 hrs	529 (19%)	6 (2%)	<0.001
>72 hrs	201 (7%)	58 (16%)	<0.001
<b>All body regions injured</b>			
Head	4,114 (86%)	n/a	n/a
Face	2,251 (47%)	n/a	n/a
Neck	252 (5%)	114 (4%)	0.002
Thorax	113 (2%)	1,261 (42%)	<0.001
Abdomen	42 (1%)	885 (29%)	<0.001
Spine	82 (2%)	118 (4%)	<0.001
Upper Extremity	213 (4%)	924 (30%)	<0.001
Lower Extremity	72 (2%)	783 (26%)	<0.001
Unspecified	64 (1%)	96 (3%)	<0.001

\*\*\*Drug use (percent to exceed 100 because many tested positively to both prescription and illegal drugs).

ED, emergency department; ICU, intensive care unit; OR, operating room; DOA, dead on arrival; min, minute; LOS, length of stay; hrs, hours.

who presented to designated trauma centers in the U.S. Our study helps to fill this void by highlighting key characteristics of those persons more likely to die at trauma centers by self-inflicted gunshot wounds.

Our study contributes to the existing literature by examining a large number of trauma patients and documenting the severity of disease, the differing outcomes related to gun type and location of injury, and the incidence of concurrent alcohol and illicit drug use. As expected, SIGSW by HGs led to more lethal conditions with lower GCS scores (less than 9), hypotension, shorter time to death window, and overall higher mortality versus the AOG group overall. Prior smaller studies have demonstrated that illicit drug or alcohol intoxication are implicated in suicide.<sup>25</sup> A previous study by Bukur et al reported that patients with SIGSWs had a high positivity rate for methamphetamines.<sup>12</sup> In our cohort, the HG group had a higher prevalence of illicit drug use, while the AOG group had a higher prevalence of alcohol and prescription drug use.

Our results also show that older, White males with handguns pose the highest risk of suicide. Screening and preventative programs should be aimed toward this particular demographic. Because anxiety and depression are common complaints in the ED, routine screening of firearm access and ownership should be performed. A study of eight EDs demonstrated that patients with suicidal ideation or attempts, who had firearms in the home, were not assessed for access to lethal means counseling.<sup>27</sup> Specifically, asking about hand gun access should be routine, integral part of the history taking of a patient suffering from anxiety, depression, or suicidal ideation. If integrated well into ED treatment plan, lethal means counseling in suicidal patients under 18 years old can be viewed as both favorable and effective. In their interventional study, Runyan and colleagues have found that all of the suicidal youth who were seen in the ED and received lethal means counseling prior to discharge had firearms locked. This is compared to initial 67% of their households reportedly keeping firearms locked prior to the counseling.<sup>28</sup>

Legislative approaches that have been used in limiting firearm access to the general public and have observed decreased incidences of mortality due to SIGSWs. Comprehensive firearm laws such as the National Firearm Agreement (NFA) in Australia limited public firearm ownership in 1996 through regulations and government buy-back program of guns from individual owners.<sup>29</sup> Several firearm observational studies have found a significant decrease in firearm associated suicides after the passing of the NFA.<sup>29,30</sup>

Another legislative approach could be to expand Gun Violence Restraining Orders (GVROs) as known as “Red Flag Laws” or “Risk Warrants” or “Extreme Risk Protection Order Laws” allow for immediate family members and law enforcement to petition a court to seize and retain firearms from persons who have potential to endanger themselves or others for a finite amount of time. Recently, in California, the GVRO was expanded to include school workers, employers, and co-workers within the last year.<sup>31-33</sup> In San Diego county, there are individual

cases that have cited the effectiveness of GVROs actually halting suicides and assault secondary firearms.<sup>33</sup> It is uncertain as to whether or not the GVROs require physicians, who are otherwise mandatory reporters, to report patients who could be potentially violent (similar to the Tarasoff rule).<sup>33,34</sup> A few studies have found that adopting and enforcing GVROs may lead to an overall decrease firearm suicide.<sup>31-35</sup> Unfortunately, enforcement of GVROs can be variable and some states and jurisdictions may enforce GVROs more heavily than others.<sup>36,37</sup> A recent longitudinal study showed that GVROs could be effective in decreasing suicides in elderly males; the same population that we found to be highest risk in our study.<sup>38</sup>

More prospective studies that can comprehensively compare gun legislation, suicide screening programs, and GVROs as interventions in different regions, counties, states in the U.S should be performed to investigate the effectiveness of these strategies in the prevention of firearm suicides.

## LIMITATIONS

This study provided a large set of the data from multiple, designated trauma centers using ICD-9 codes. The e-codes provided a more reliable set of data than self-reported data. However, there are limitations to using e-codes. Most importantly, data may have been lost or miscoded due human error. Cases are restricted to patients who were seen in the emergency department at a designated trauma center. Therefore, cases of SIGSWs may have been missed due to the fact that the patient did not present to a designated trauma center or may have died prior to arrival to the hospital. Also, the mechanism of injury may not have been known at the of time of ED evaluation and thus not properly e-coded and included within our data.

Additionally, there were 1,405 patients where the weapon type was not clearly identified and another 154 cases that could not be confirmed as SIGSW. As discussed earlier, the intention of the shooter was not completely known and the events leading to the patient’s presentation to the designated trauma center were largely unwitnessed. It cannot be completely known whether or not these the SIGSWs had suicidal intent. The data regarding patients’ toxicology results may also be inaccurate, due to the lack of complete data. Finally, for patients who presented DOA, laboratory evaluation may not have been performed prior to the patient being deceased, creating additional missing data points.

## CONCLUSION

In this large, retrospective study of SIGSWs presenting to designated Trauma Centers in the U.S., handguns were more commonly associated with lethal or near-lethal injuries. Our findings demonstrate that older, White males, who own handguns, are the most at-risk group for lethal and near-lethal SIGSWs. We hope that this study helps demonstrate the crucial need to improve our current gun legislation and to integrate lethal means firearm screening programs in the ED for the most vulnerable patients.

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*Address for Correspondence:* Faith Quenzer, DO, University of California, San Diego Medical Center, Department of Emergency Medicine, 200 West Arbor Drive Mail Code #8676, San Diego, California, 92103. Email: fquenzer@gmail.com.

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# Documentation of Screening for Firearm Access by Healthcare Providers in the Veterans Healthcare System: A Retrospective Study

Cynthia A. Brandt, MD, MPH<sup>†\*</sup>

T. Elizabeth Workman, PhD<sup>‡§§</sup>

Melissa M. Farmer, PhD<sup>§</sup>

Kathleen M. Akgün, MD, MS<sup>†\*\*</sup>

Erica A. Abel, PhD<sup>†¶</sup>

Melissa Skanderson, MSW<sup>†</sup>

Bevanne Bean-Mayberry, MD, MHS<sup>§¶</sup>

Qing Zeng-Treitler, PhD<sup>‡§§</sup>

Maryann Mason, PhD<sup>#</sup>

Lori A. Bastian MD, MPH<sup>†\*\*</sup>

Joseph L. Goulet, PhD<sup>†\*</sup>

Lori A. Post, PhD<sup>#††</sup>

\*Yale School of Medicine, Department of Emergency Medicine, New Haven, Connecticut

†VA Connecticut Healthcare System, West Haven, Connecticut

‡The George Washington University, Biomedical Informatics Center, Washington, District of Columbia

§Center for the Study of Healthcare Innovation, Implementation & Policy (CSHIIP), VA Greater Los Angeles Healthcare System, Los Angeles, California

¶Yale School of Medicine, Department of Psychiatry, New Haven, Connecticut

¶¶UCLA David Geffen School of Medicine, Department of Medicine, Los Angeles, California

#Northwestern University, Department of Emergency Medicine, Chicago, Illinois

\*\*Yale School of Medicine, Department of Internal Medicine, New Haven, Connecticut

††Northwestern University, Department of Geriatric Medicine, Chicago, Illinois

§§VA Medical Center, Washington, District of Columbia

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**Introduction:** Presence of a firearm is associated with increased risk of violence and suicide. United States military veterans are at disproportionate risk of suicide. Routine healthcare provider screening of firearm access may prompt counseling on safe storage and handling of firearms. The objective of this study was to determine the frequency with which Veterans Health Administration (VHA) healthcare providers document firearm access in electronic health record (EHR) clinical notes, and whether this varied by patient characteristics.

**Methods:** The study sample is a post-9-11 cohort of veterans in their first year of VHA care, with at least one outpatient care visit between 2012-2017 (N = 762,953). Demographic data, veteran military service characteristics, and clinical comorbidities were obtained from VHA EHR. We extracted clinical notes for outpatient visits to primary, urgent, or emergency clinics (total 105,316,004). Natural language processing and machine learning (ML) approaches were used to identify documentation of firearm access. A taxonomy of firearm terms was identified and manually annotated with text anchored by these terms, and then trained the ML algorithm. The random-forest algorithm achieved 81.9% accuracy in identifying documentation of firearm access.

**Results:** The proportion of patients with EHR-documented access to one or more firearms during their first year of care in the VHA was relatively low and varied by patient characteristics. Men had significantly higher documentation of firearms than women (9.8% vs 7.1%;  $P < .001$ ) and veterans >50 years old had the lowest (6.5%). Among veterans with any firearm term present, only 24.4% were classified as positive for access to a firearm (24.7% of men and 20.9% of women).

**Conclusion:** Natural language processing can identify documentation of access to firearms in clinical notes with acceptable accuracy, but there is a need for investigation into facilitators and barriers for providers and veterans to improve a systemwide process of firearm access screening. Screening, regardless of race/ethnicity, gender, and age, provides additional opportunities to protect veterans from self-harm and violence. [West J Emerg Med. 2021;22(4.1):101-108.]

## INTRODUCTION

In 2020 42% of United States (US) households reported owning a firearm.<sup>1</sup> Firearms in the home increase risk of violent events,<sup>2-5</sup> and is a significant threat to public health. Nearly half (44.9%) of all US military veterans own a firearm, with ownership reportedly higher among males (47.2%).<sup>6</sup> Veterans are at disproportionate risk for suicide,<sup>7</sup> accounting for 20% of suicide deaths despite constituting 13% of the US population. Firearms are involved in 67% of suicides among veterans compared with 50% of the general public.<sup>8</sup>

While access to firearms is associated with increased risk for injury and death, safe firearm storage is associated with decreased risk.<sup>9,10</sup> Public health advocates recommend strategies to restrict access to lethal means as a suicide prevention strategy.<sup>11</sup> For firearms these processes include safe storage measures such as gun safes, gun locks, storage of ammunition and guns separately, and storage of guns unloaded and locked.<sup>12</sup> Members of the military tend to store firearms unsafely with 45.2% reporting they store firearms both loaded and unlocked, and an additional 33% store firearms either loaded or unlocked.<sup>13,14</sup>

Screening veterans for firearms ownership and safe storage is needed to prevent unnecessary injuries and deaths. Healthcare providers are in a position to screen and counsel patients on safe firearm storage.<sup>4</sup> Counseling on health and safety is a well-established healthcare practice; there are guidelines for screening and counseling in many areas of health including healthy eating, physical activity, mental health, and injury prevention.<sup>15</sup> While firearm-related injuries and deaths are a public health problem, particularly in the US,<sup>16</sup> a minority of physicians report engaging in firearm counseling.<sup>17</sup> Despite several groups having recommended both targeted and universal screening for firearm access,<sup>17-24</sup> there are no current national guidelines for screening in primary care, urgent care or emergency care settings even though gun safety is associated with lower risk of injuries and death.<sup>25,26</sup>

To understand how current practice may be adapted, more information on the frequency with which healthcare providers document firearm screening is needed. In this study we present results of Veterans Health Administration (VHA) healthcare providers' documentation of firearm access screening in electronic health record (EHR) notes among VHA patients in outpatient primary care, urgent care, and emergency department (ED) settings.

## METHODS

The study is a cross-sectional examination of the frequency of documentation of screening for veterans' access to firearms across several healthcare settings using natural language processing (NLP), which refers to automatic computational processing of human language.<sup>27</sup> The study was approved by the Veterans Administration Connecticut

### *Population Health Research Capsule*

What do we already know about this issue?  
*United States Veterans are more likely to own a firearm and to be at risk for firearm injuries and death than civilian populations.*

What was the research question?  
*Our study aimed to determine how frequently VA healthcare providers document firearm access screening.*

What was the major finding of the study?  
*Documentation of firearm access for Veterans by healthcare providers was low but higher in men than women.*

How does this improve population health?  
*Identifying barriers and facilitators to help healthcare providers increase screening for firearms and counsel safe storage could support prevention efforts.*

Healthcare System Institutional Review Board.

The study sample included men and women veterans from a national, post-9-11 cohort<sup>28,29</sup> during their first year of VHA healthcare, defined by the presence of at least one primary care visit from 2012-2017. We obtained data on demographic and veteran military service characteristics from the Defense Manpower Data Center-Contingency Tracking System Deployment File, provided to the VHA from the US Department of Defense. Variables included age, gender, race/ethnicity, marital status, education, rank (e.g., officer, enlisted), military branch (e.g., Army, Marine Corps), and deployment dates. VHA visit information came from EHR data extracted from the Corporate Data Warehouse (CDW). The CDW includes information on healthcare utilization, pharmacy, laboratory, vital signs, coded diagnostic and procedural data (*International Classification of Diseases*, 9th and 10th revisions, Clinical Modification [ICD-9-CM and ICD-10-CM]) and Current Procedural Terminology (associated with all VHA inpatient and outpatient encounters).<sup>30,31</sup>

We identified comorbid conditions using ICD-9 and ICD-10 coded diagnoses defined by  $\geq 2$  outpatient (on separate days) or  $\geq 1$  inpatient code for the condition. This methodology has been used for the identification of psychiatric disorders in administrative data<sup>32</sup> and human immunodeficiency virus in Medicaid data.<sup>33</sup> Diagnostic code groupings were previously validated.<sup>34</sup> Major mental health diagnoses included post-traumatic stress disorders (PTSD), major depressive disorders,

alcohol use disorders, and substance use disorders.

## Natural Language Processing Tool Development and Performance for Firearm Access Identification

### Firearm Taxonomy

For the information extraction process, we developed a coding manual for chart review and a taxonomy for firearms for annotation. A taxonomy was created by searching existing vocabularies (NCBIO, UMLS, SnoMed) and the literature for published ontologies used for guns, gunlock, and firearms. A Cochrane review on gunshot wounds contained terms such as trauma\* or injur\* or penetrat\* or wound\* or perforat\* or stab\* or gunshot or shot, and the Medical Subject Headings (MeSH) database included the following: “Wounds, Gunshot”[Mesh] OR “Wounds, Penetrating”[Mesh:NoExp] OR “Multiple Trauma”[Mesh]) OR “polytrauma.” This list of terms was supplemented with over 120 candidate terms and phrases contained in a national database<sup>35</sup> on firearm homicides. We then reviewed and narrowed the phrases down to 27 (shown in Table 1) deemed relevant by VHA clinicians.

### Annotation

We identified 2,584,607 notes with one or more of the phrases, and annotated 1856 text snippets randomly selected from notes that contained any of the search terms. Each snippet contains a 35-word span before and after a firearm-relevant phrase. The annotation classifications for firearm access were the following: positive (ability to determine that the veteran had current access to at least one firearm); negative (language that the veteran did not have current access to any firearms); and ambiguous (there was insufficient evidence for either a positive or negative classification from the note – an example

might be that the veteran owned a firearm but it was somewhere else). Each snippet was annotated by two of the authors and disagreement adjudicated by their consensus. An inter-annotator agreement was calculated. The annotated snippets served as the reference standard in training and testing.

### Features

We used n-grams as features. In clinical text, unigrams are single words, and bigrams are two words that occur in a sequence. For example, in the phrase “patient owns a shotgun” the unique unigrams are *patient*, *owns*, *a*, and *shotgun*. In the same phrase, *patient\_owns*, *owns\_a*, *a\_shotgun* are unique bigrams. Alpha or numeric tokens (discrete words and numbers) were counted in the unigrams and bigrams. The features included unique unigrams with a frequency greater than 34, and unique bigrams in the annotation spans with a frequency greater than four. These thresholds are empirically chosen to filter out the less prevalent n-grams and reduce overfitting. The training features for the model (for each document) consisted of binary indications of the presence of each of the identified unigrams and bigrams, along with the offset location of the keyphrase in the snippet.

### Training and Testing

We used the annotated snippets to train a random forest model with 200 estimators or trees. The random forest model maximum depth was set to 15, with maximum features automatically determined by the model and the gini split criterion. Hyperparameters were determined through gridsearch and other testing. We split the 1856 text snippets into 85% for training and 15% for testing. The model performance was measured by accuracy.

### Validation

For validation, we annotated an additional 238 clinical notes on the note (instead of the snippet) level, with 175 negative and 63 positive for firearm access. The random forest model was applied to these notes, based on the snippet identified in each document. Figure 1 below is a schematic of this process.

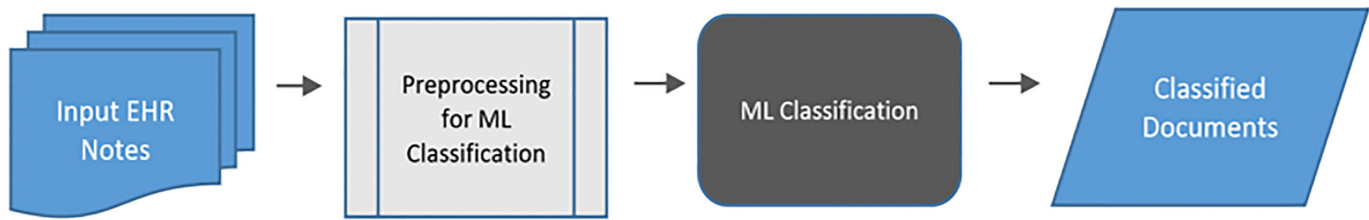
### Statistical Analysis

We conducted all statistical analyses using SAS software version 9.4 (SAS Institute, Cary, NC). Baseline characteristics of veterans include frequency (percentages) and means ( $\pm$  standard deviations) or median (interquartile range), and differences by age, race, ethnicity and gender were examined using chi-squared test or Student’s t test, as appropriate. We used a multivariable logistic regression model to assess firearm mention and adjust for potential confounding based on the literature. Among those with firearm mention, a logistic model was run to assess firearm access. We examined model fit using quasi-information criterion and residual plots. Hypotheses were tested at a two-sided significance level of  $\alpha = 0.05$ .

**Table 1.** Counts of firearm-related terms found in notes (N = 27 terms).

Term	Count	Term	Count
Rifle	45,897	38 caliber	58
Pistol	32,893	9 mm Beretta	49
Shotgun	25,761	Arms dealer	51
12 gauge	848	Blue suicide	3
9 mm Glock	59	Home invasion	2,940
45 caliber	417	Minigun	6
22 caliber	281	Mossberg shotgun	6
Semiautomatic	90	Pistol whip	105
357 Magnum	140	Revolver	2,295
M1 rifle	4	Ruger pistol	5
Gun	653,308	Smith and Wesson	253
Guns	423,119	Sniper rifle	370
Firearm	305,766	Winchester rifle	8
Firearms	1,089,875		

mm, millimeter.



**Figure 1.** Application pipeline. EHR, electronic health record; ML, machine learning.

## RESULTS

The Cohen kappa score measuring inter-annotator agreement among the review team members identifying screening documentation incidents was 80%. On the testing dataset (15%), the accuracy was 81.0%. On the final validation dataset, the random forest model achieved 81.9% accuracy, 90.9% specificity, 57.1% sensitivity, and positive predictive value of 69.2% in classifying the 238 test notes. Table 1 demonstrates the frequency of the most common firearm-related terms within the VHA text notes. These counts are non-distinct by patient but demonstrate the breadth of terms used in clinical notes by providers; many of the highly specific terms were present in notes as historical and exposure events for PTSD documentation, and/or noise exposure (out of 105,316,004 outpatient care notes).

We included data during the first year in VHA care for 762,953 veterans in the analytic sample. Table 2 demonstrates the frequency of documentation of access to firearms and other guns by clinicians within one year of entry into VHA healthcare. The mention of any firearm within a clinical note for veterans was 9.8% of men, 7.1% of women, and 6.5% in veterans over 50 years of age. Among the small number of veterans with any firearm term present, only 24% were classified as positive for access to a firearm (24.7% of men and 20.9% of women [data not otherwise shown]). Prevalence patterns by race of any mention/positive access were similar, with the highest rates among Whites (9.6% mention and 26.3% access [data not otherwise shown]). Documentation of firearms was higher in veterans with higher numbers of mental health visits, emergency and urgent care visits than primary care. Documentation of firearms did not vary regardless of the number of primary care visits (data not shown). After adjustment for demographics, utilization, and comorbidities, significant differences in documentation of access remained by age, gender, and among veterans with major depression or PTSD diagnoses.

## DISCUSSION

Results demonstrate documentation of firearm access in clinical notes for less than 10% of contemporary veterans within the first year of enrollment in VHA healthcare, and that nearly one quarter of those with documentation were identified

as having access to a firearm. There was a significantly lower rate of documented access for women veterans, despite data that show high rates of both men and women veterans who live in homes with firearms, and increasing rates of firearm-related suicides among women veterans.<sup>6,36</sup> While documentation does not always equate with conversations between providers and patients, the low frequency of documented patient-provider interactions seen in this population suggests that there is a clear opportunity to increase initiation of conversations about firearm access and safety. Barriers to implementation of firearm screening and safety counseling include provider uncertainty about the effectiveness of firearm screening, provider uncertainty about the legality of asking about firearm ownership, and provider unfamiliarity with firearms. Further, provider unfamiliarity with lethal means restriction as a firearm suicide prevention strategy may prohibit uptake of screening and counseling.<sup>17,23,37-39</sup> These barriers indicate a need for increased training of healthcare providers on firearm screening and safety counseling and normalizing the opportunities to discuss firearms in a population that has higher rates of firearm ownership and use.

Discussions must be acceptable to providers and to patients for it to be effective. Roszko and colleagues' review of 53 studies of non-veteran clinician firearm attitudes and practices found that positive attitudes toward firearm discussions were higher than actual documented discussions, with low firearm discussions across all disciplines.<sup>17</sup> This is encouraging in that it could indicate healthcare providers may be willing to undergo training in initiating and carrying out these discussions, although it remains to be seen whether attitudes differ among VA providers.

While providers may have positive attitudes toward firearm screening and counseling, recent studies show mixed support by gun owners and veterans for healthcare provider initiation of gun safety conversations.<sup>11,40</sup> This suggests that while providers may be willing to initiate these discussions, it is not clear that patients will welcome or participate in them if initiated. Such conversations will need to be clearly delineated as prevention oriented for gun-owning citizens and families with specific, evidence-based practices such as the following: Homes with locked guns are less likely to have unintentional or self-inflicted injuries with firearms or deaths.<sup>41</sup>

**Table 2.** Documentation of access to firearm by covariates with adjusted models for any firearm documentation and access.

	Any documentation, n= 762,953			Adjusted model 1		Adjusted model 2	
	No	Yes		Mention		Access among any documentation	
	N = 690,599 (91%)	No access, N = 54,672 (76%)	Access, N = 17,601 (24%)	OR (95% CI)	P-value	OR (95% CI)	P-value
Gender							
Female	90,282 (13.07)	5,451 (9.97)	1,440 (8.18)	1	n/a	1	n/a
Male	600,398 (86.93)	49,221 (90.03)	16,161 (91.82)	1.45 (1.41, 1.50)	<0.001	1.19 (1.12, 1.27)	<0.001
Age groups, n (%)							
<30	80,598 (11.67)	6,116 (11.19)	1,927 (10.95)	1	n/a	1	n/a
30-49	471,218 (68.23)	41,083 (75.15)	13,515 (76.8)	0.88 (0.86, 0.90)	<0.001	0.99 (0.94, 1.05)	0.008
50+	9,623 (20.1)	7,467 (13.66)	2,156 (12.25)	0.61 (0.59, 0.63)	<0.001	0.89 (0.82, 0.95)	<0.001
Race/ethnicity, n (%)							
White	438,847 (63.54)	34,402 (62.92)	12,247 (69.58)	1	n/a	1	n/a
Black	123,115 (17.83)	10,246 (18.74)	2,607 (14.81)	1.04 (1.02, 1.06)	0.0002	0.73 (0.69, 0.76)	<0.001
Hispanic	80,443 (11.65)	6,651 (12.17)	1,738 (9.87)	0.96 (0.93, 0.98)	<0.001	0.72 (0.68, 0.76)	<0.001
Other	48,275 (6.99)	3,373 (6.17)	1,009 (5.73)	1.02 (0.99, 1.06)	0.2	0.84 (0.78, 0.91)	0.2
MDD, n (%)	147,787 (21.4)	21,949 (40.15)	8,154 (46.33)	1.43 (1.40, 1.45)	<0.001	1.25 (1.20, 1.30)	<0.001
PTSD, n (%)	277,536 (40.18)	38,082 (69.66)	13,300 (75.56)	2.24 (2.20, 2.29)	<0.001	1.25 (1.20, 1.30)	<0.001
Smoking, n (%)							
Never	266,593 (41.14)	18,245 (34.01)	5,438 (31.23)	1	n/a	1	n/a
Past	286,280 (44.18)	28,707 (53.51)	9,631 (55.32)	1.08 (1.06, 1.10)	<0.001	1.05 (1.00, 1.09)	0.7
Current	95,102 (14.68)	6,695 (12.48)	2,341 (13.45)	0.99 (0.96, 1.01)	<0.001	1.11 (1.05, 1.17)	0.002
Chronic pain, n (%)	62,808 (9.09)	8,755 (16.01)	2,991 (16.99)	1.06 (1.03, 1.09)	<0.001	1.03 (0.98, 1.08)	0.3
TBI screen, n (%)	616,836 (89.31)	51,867 (94.87)	16,874 (95.87)	1.04 (0.99, 1.09)	0.09	0.99 (0.89, 1.09)	0.8
MST screen, n (%)	630,124 (91.23)	52,330 (95.72)	16,971 (96.42)	0.91 (0.87, 0.96)	0.0007	0.92 (0.83, 1.03)	0.1
Bipolar, n (%)	24,226 (3.51)	4,394 (8.04)	1,414 (8.03)	1.09 (1.05, 1.12)	<0.001	0.95 (0.89, 1.01)	0.1
ODU, n (%)	215,791 (31.24)	27,274 (49.89)	9,269 (52.66)	1.08 (1.06, 1.10)	<0.001	1.01 (0.97, 1.05)	0.6
Alcohol, n (%)	62,690 (9.08)	11,203 (20.49)	4,049 (23.00)	1.18 (1.16, 1.21)	<0.001	1.1 (1.05, 1.15)	<0.001
Drug, n (%)	63,683 (9.22)	11,743 (21.48)	3,696 (21.00)	0.96 (0.94, 0.99)	0.003	0.80 (0.76, 0.84)	<0.001
# ED visits, mean (SD)	0.30 (0.91)	0.59 (1.46)	0.60 (1.38)	1.03 (1.03, 1.04)	<0.001	0.99 (0.98, 1.00)	0.07
# MH visits, mean (SD)	3.32 (8.93)	11.53 (17.70)	12.66 (16.63)	1.03 (1.03, 1.03)	<0.001	1.00 (1.00, 1.00)	0.0002

In descriptive statistics, all variables were significant at  $p < 0.05$ , except Bipolar and Drug. Models were adjusted for # of ER and MH visit at baseline; 43,921(5%) were missing smoking.

ODU, opioid use disorder; OR, odds ratio; CI, confidence interval; MDD, major depressive disorder; PTSD, post-traumatic stress disorder; ED, emergency department; MH, mental health; SD, standard deviation; TBI, traumatic brain injury; MST, military sexual trauma.

Perhaps related to the reasons specified above, the evidence for the effectiveness of this firearm safety conversation in the clinical setting is mixed.<sup>42,43</sup> For this reason, appropriate, acceptable communication must be used and evaluated to maximize the impact and inform the knowledge base of these efforts in the clinical setting.<sup>44,45</sup> However, a recent epidemiologic review indicates that counseling combined with safety-device provision can impact safe storage in the community.<sup>41</sup> Promising strategies include following the guiding principles of shared decision-

making, with providers stating neutral risks and protective factors related to gun safety and involving gun owners in the development of messaging.<sup>46,47</sup> These neutral risks can be culled from the US Centers for Disease Control and Prevention data as simple facts for patients to understand and acknowledge as part of their gun ownership responsibilities.<sup>48</sup>

Specific to the VHA, an appropriate clinical response to the public health problem of firearm suicide in the veteran population is needed. Further research within the VHA is needed to determine the healthcare setting(s) and provider

types most appropriate for firearm screening and counseling interventions. This step will require a participatory approach among health services and informatics researchers to improve the feasibility, acceptability, relevance, and sustainability of interventions.<sup>49-52</sup> In addition, research is needed to determine the modality and intervention format (electronic, face to face, written) that are most effective for each of the key domains in firearm injury research. Data on the moderators of acceptability and effectiveness (demographics, political views, comorbidities, etc.) of screening and interventions from the veteran and provider perspectives are needed. Only then can researchers begin to measure the short- and longer-term outcomes of such interventions and policies. While this approach is clearly specific to the clinical context and persons involved for veteran prevention with firearms, prevention is likely best on the frontlines of care and where repeated encounters occur with trust-building relationships. Thus, primary care, mental health and ED settings/providers may need to partner with the health services and health informatics researchers to fully address the scope of this need and develop interventions that fit the veteran patients and the VHA system. Equipped with information and curiosity, clinicians can engage their veteran patients as part of routine care, instead of urgent or emergent care, and the health services and health informatics teams can inform us about which methods are most feasible and impactful for veteran quality of life and provider use and sustainability.

## LIMITATIONS

Given retrospective studies may introduce sampling bias<sup>53</sup>, we included the entire population, not a sample. The results of the NLP algorithm were limited for the first year of entry into VHA healthcare for years 2012-2017, which might underestimate firearm documentation. The identification of firearm documentation for patterns such as temporal changes, variations in types of providers and provider settings, and other patient characteristics will be explored in future work. For example, in this sample there were increases by year (from 3% in 2012 to 21% in 2017). Further research is needed to help explain this increase.

## CONCLUSION

Natural language processing methods are able to determine the prevalence of documented firearm screening and safety counseling across a large population of US military veterans. We identified low prevalence of firearm access screening documentation and believe that further investigation into facilitators and barriers is necessary. This work should inform the process for development of systemwide practices to reduce firearm suicide and injury among US veterans, a large group at elevated risk.

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*Address for Correspondence:* Cynthia A. Brandt, MD, MPH, Yale School of Medicine, Department of Emergency Medicine, 464 Congress Ave., Suite 26, New Haven, CT 06519-1315. Email: Cynthia.brandt@yale.edu.

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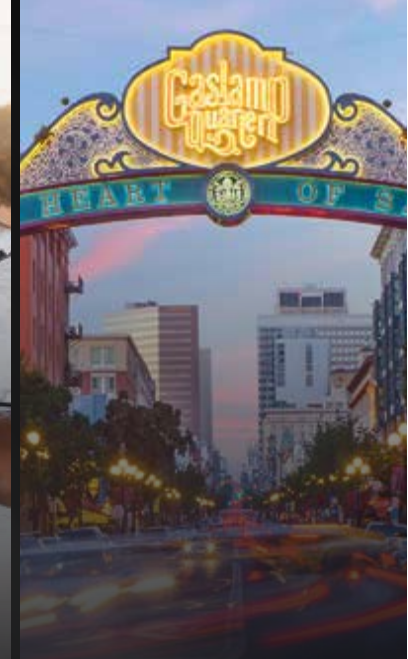
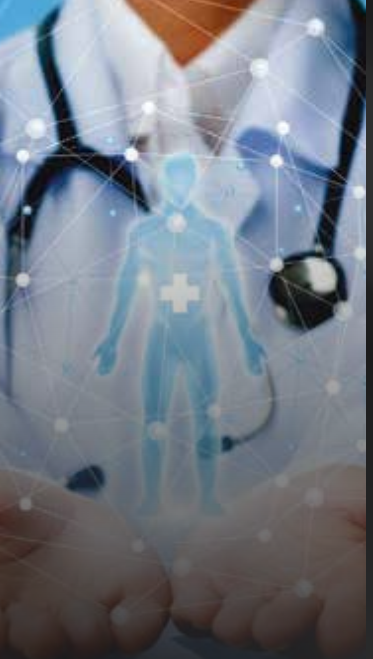
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