



# Trends and Burden of Firearm-related Hospitalizations in the United States Across 2001-2011

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## ABSTRACT

**BACKGROUND:** Firearm-related hospitalizations are a major burden to the current health care infrastructure. We examined the trends in the incidence and case-fatality rates of firearm-related hospitalizations over the past decade. We also hypothesized that major national economic perturbations would be partly responsible and correlate temporally with national firearm-related hospitalization trends.

**METHODS:** We used the 2001-2011 Nationwide Inpatient Sample for analysis. Firearm-related hospitalizations were identified using International Classification of Diseases, 9<sup>th</sup> Revision codes. In addition, we examined the relationship between the US stock market performance (Dow Jones Industrial Average) and the annual firearm-related hospitalization incidence rates.

**RESULTS:** In the last decade, there has been a modest decline in firearm-related hospitalizations, interrupted by spikes in the annual incidence that closely corresponded to periods of national economic instability. In addition, the overall case-fatality rate following firearm-related hospitalization has been stable at ~8%; the highest rates being present among those who attempted suicide using firearms. Also, there has been an increase in the prevalence of mental health disorders among individuals admitted with firearm-related injuries. Moreover, there was an increase in the length of stay and the cost/charges associated with hospitalization over the last decade.

**CONCLUSION:** Over 2001-2011, the national incidence of firearm-related hospitalizations has closely tracked the national stock market performance, suggesting that economic perturbations and resultant insecurities might underlie the perpetuation of firearm-related injuries. Although the case-fatality rates have remained stable, the length of stay and hospitalization costs have increased, imposing additional burden on existing health care resources.

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**KEYWORDS:** Case fatality; Cost of illness; Firearms; In-hospital mortality; Length of stay

Firearms are the second leading cause of injury-related deaths after motor vehicle accidents in the US.<sup>1</sup> Although the rates of firearm-related injuries have decreased over the last 2 decades, mortality resulting from firearms in the US remains the highest in the world.<sup>2</sup> The mass shooting incidents that have occurred recently in Newtown,

Connecticut; Tucson, Arizona; Virginia Tech University; Columbine High School; and at the Washington Navy Yard have brought firearm-related violence to the forefront of national discussion.<sup>3</sup> Although these mass shootings killed several people, injured numerous others, and stirred up a major national debate about gun policies, these shootings represent only the tip of the iceberg. Approximately 88 people are believed to die every day due to a direct firearm-related injury, including suicides, homicides, unintentional injuries, or accidents.<sup>3</sup> Homicides and suicides by firearms result in 11,000 and 20,000 deaths, respectively, each year.<sup>4</sup> In addition, the number of nonfatal firearm injuries is roughly 40 times higher than the number of fatal firearm injuries.<sup>5</sup>

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It appears that firearm-related injuries are a major burden on our health care system and consume a large portion of already-constrained health care resources. Besides being a criminal justice issue, firearm-related injuries have become a major public health challenge facing the nation. Although there is a large amount of literature detailing the vital statistics of firearm-related injuries, there is a conspicuous paucity of literature exploring the burden on health care resources imposed by firearm injuries. To that end, we conducted a detailed analysis of trends in the incidence rates and in-hospital case-fatality rates of firearm-related hospitalizations over the last decade using a large, well-validated nationwide database. Based on the understanding of the socioeconomic factors that contribute to the use of firearms in the current society, one could surmise that there would be a strong relationship between the national economic situation and national firearm-related hospitalization rates. This led us to hypothesize that major national economic perturbations partly would be responsible and correlate temporally with national firearm-related hospitalization trends.

## METHODS

### Data Source

Data were obtained from the Nationwide Inpatient Sample (NIS) database from 2001-2011. The NIS is sponsored by the Agency for Healthcare Research and Quality (AHRQ) as a part of Healthcare Cost and Utilization Project (HCUP). The number of states that contribute the discharge-level data to the NIS has grown from 33 in 2001, covering 81% of the entire US population, to 44 in 2011, covering over 90% of the entire US population. Currently, the NIS contains discharge-level data from approximately 8 million hospitalizations annually from about 1000 hospitals across the US. This database is designed to represent a 20% stratified sample of all hospitals in the country. Criteria used for stratified sampling of hospitals into the NIS include location (urban or rural), teaching status, geographic region, patient volume, and hospital ownership. All data available from the HCUP have been de-identified and hence, the analysis is exempt from the federal regulations for the protection of human research participants. The dataset was obtained from the AHRQ after completing the data use agreement with HCUP.

### Study Population

The NIS database provides up to 15 diagnoses and 15 procedures for each hospitalization record for the years

2001-2009. The number of diagnoses coded in the database was expanded to 25 for the years 2010-2011. All these have been coded using the standard International Classification of Diseases, 9<sup>th</sup> edition, Clinical Modification (ICD-9 CM) codes. In addition, we used the HCUP Clinical Classification Software (CCS) to identify patient comorbidities and specific procedures.<sup>6,7</sup> CCS has been developed by the AHRQ for clustering patient diagnoses and procedures into a manageable number of clinically meaningful categories.<sup>6,7</sup> Information on firearm-related hospitalizations was derived using the E codes of the ICD-9 as well as the CCS. All firearm-related hospitalizations were identified using the CCS code 2605, in addition to the standard ICD-9 codes. Types of firearm-related hospitalization, as defined by the cause, included suicide (E950-E959), assault (E960-E969), and others; including accidents (E922.0-E922.3, E922.8, E922.9), legal intervention (E970), undetermined event (E985.0-E985.3), and war (E991).

The entire study duration of 2001-2011 was analyzed as 2 distinct intervals: an early period consisting of years 2001-2006, and a later period consisting of years 2007-2011. Demographic variables available for analysis included age, sex, race (white, black, other), primary source of payment, weekday vs weekend admission, along with relevant comorbidities including smoking, alcohol use, substance use, and mental health disorders. The history of smoking, alcohol use, substance use, and mental health disorders was reliably coded starting in 2007 in the NIS database and hence, analysis of these variables was restricted to the time period 2007-2011 only. The mental health disorders included adjustment disorders (CCS code 650), anxiety disorders (CCS code 651), attention-deficit, conduct, and disruptive behavior disorders (CCS code 652), delirium, dementia, cognitive, and amnesic disorders (CCS code 653), impulse control disorders (CCS code 656), mood disorders (CCS code 657), personality disorders (CCS code 658), and psychotic disorders (CCS code 659). Hospital characteristics such as region (Northeast, Midwest, South, West), bed size (small, medium, large), location (rural, urban), hospital control (government, private), and teaching status were also included. In addition, NIS has classified the residential zip code of each patient into quartiles based on median household income of each zip code, which was utilized as a surrogate for socioeconomic status of each firearm-related hospitalization. Several prior studies have validated this approach for imputing individual socioeconomic status in epidemiologic settings.<sup>8,9</sup>

### CLINICAL SIGNIFICANCE

- Over the last decade, the incidence of firearm-related hospitalizations has closely tracked the national stock market performance, suggesting that economic perturbations and resultant insecurities might underlie the perpetuation of firearm-related injuries.
- Although the case-fatality rates have remained stable, the length of stay and hospitalization costs have increased, imposing additional burden on existing health care resources.

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