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Improving Data Infrastructure to Reduce Firearms Violence

Chapter 2. Improving the Capacity of Hospital ED Data Systems to Track Nonfatal Firearm Injuries

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Introduction

Most firearm injuries lead to a trip to the ED, not a trip to the morgue. Yet today in the United States, we have no data system that accurately tracks how many nonfatal firearm injuries occur, where and to whom they occur, and whether they resulted from assault, accident, self-harm, or legal intervention. Currently, there are two long-standing national data systems for ED visits that come close to providing this information, and a third very new system shows promise.³

If the changes to three hospital data systems that we recommend in this report are implemented in the short term, we can reasonably expect that within three years the nation will have:

- Stable, annual estimates of ED-treated firearm injuries at the national level from a sample of about 1,000 emergency departments, and an annual census of ED-treated firearm injuries at the state and local level in nearly all states.
 - ▶ *FROM:* For national estimates: the NEDS from the HCUP. For state and local data: SEDDs and SIDs from state organizations or, in many states, from HCUP.
 - ▶ *PROBLEM TO SOLVE:* Currently, hospital medical records coding systems that supply data to NEDS, SIDs, and SEDDs misclassify a large proportion of intentional injuries as accidents.
 - ▶ *SOLUTION:* Recommend a new guideline to the national committee that governs how injuries are coded in hospital billing data, and work with relevant industry stakeholders (hospital information managers, coders, and the software companies whose products support coding) to ensure the new guideline is implemented.
- National estimates of firearm injuries that are accurately classified by intent type, based on a small sample of hospitals.
 - ▶ *FROM:* NEISS-FISS.

³ A fourth, the National Hospital Ambulatory Medical Care Survey, exists but does not have sufficient case size to reliably estimate firearm injuries. Additionally, a private initiative, the National Trauma Data Bank, provides useful detail; however, because 30% of firearm injuries are not treated in trauma centers, we focus in this report on ED data systems from all acute care hospitals, regardless of trauma center designation.

- ▶ *PROBLEM TO SOLVE*: While coding of injury intent is good, sample limitations of the current public-facing data interface result in national estimates with such wide confidence intervals that they do not meet the CDC’s criteria for public release.
- ▶ *SOLUTION*: Support and maintain the sample design improvements currently underway.
- A near real-time census of ED-treated firearm injuries at the state and local level in ten states, with potential for nationwide implementation.
 - ▶ *FROM*: Firearm Surveillance Through Emergency Rooms (FASTER), based on NSSP.
 - ▶ *PROBLEM TO SOLVE*: While NSSP dates back nearly 20 years, FASTER only began in 2021 and must prove that it can rapidly and accurately identify firearm injuries from NSSP.
 - ▶ *SOLUTION*: If FASTER proves viable, expand to other states, and create a national, online data querying interface to facilitate access to aggregate state, local, and national data.

Emergency Departments are an Important Data Source for Firearm Injury

An estimated 90 percent of people who sustain nonfatal gunshot wounds⁴ (with the exception of minor graze wounds) are seen in the ED. Some evidence:

- 91 percent of jail inmates in five cities who were previously shot reported that they were treated in the hospital for their injuries.ⁱ
- 88 percent of people who received medical care for assaultive gunshot wounds were treated in a hospital, according to NCVS data.ⁱⁱ The others were treated at the scene or at a home; none were treated only in a doctor’s office or non-hospital facility.
- The total number of nonfatal gunshot wounds estimated by the NEDS appears to be in the right ballpark. How can we tell? By working backward from fatalities. That is, if we know the number of firearm-related homicides, accidents, and suicides, and we know that for firearm injuries roughly 1-in-5 assaults, 1-in-20 accidents, and 9-in-10 self-inflicted shootings result in death, we can estimate annual nonfatal injuries based on deaths.ⁱⁱⁱ
- A current study^{iv} is reviewing hospital charts for firearm injuries. Less than half a percent were cases in which a patient with a gunshot wound appeared for care days or weeks after being shot because they initially did not seek ED care for fear of being reported to police or some other reason.^v Presumably, if a substantial proportion of shooting victims avoid hospital care, late presentations for pain or wound infection would be more common.

⁴ Throughout we use the terms “gunshot wound” and “firearm injuries” to refer to injuries from a traditional projectile fired from a firearm. We exclude injuries caused by non-powder guns such as BB guns, air guns, and flare guns; non-projectile injuries like pistol whipping; or injuries from non-traditional projectiles like rubber bullets or bean bags.

What Can and Cannot Be Expected from Hospital Surveillance

Surveillance⁵ systems collect ongoing, accessible, comparable, and representative data and make it available (with confidentiality protections) to researchers, health and safety officials, and the public to help monitor and address public health problems. They differ from research studies, which are short term and cannot monitor trends over time. Research studies design instruments to collect exactly the information that they need. Many surveillance systems (including those described here) rely on existing administrative records, such as hospital billing data or medical charts, and the data they already contain. As such, users must recognize the strengths and limitations of these administrative systems. For example, hospitals may be an imperfect source of data on the specific firearm type that was used in an assault (look to police data for that), but an excellent source of information on medical severity or injuries that may not come to the attention of the police, like suicide attempts.

The nationally standardized format for hospital billing data uses a coding system that identifies injuries by their mechanism (e.g., firearm, sharp instrument) and intent (e.g., assault, accident, self-harm, legal intervention). These data are sent to statewide databases in nearly all states, and many of these states submit their statewide databases to the HCUP from which nationally representative datasets like NEDS are assembled. That this administrative data infrastructure already exists at the hospital, state, and national level is a tremendous strength. It will be an even greater strength when coding of intent improves and when the data are made more accessible.

Since the intent coding problem may prove difficult to solve, improving the NEISS system is also a prudent step, since the quality of intent coding in NEISS is already high and steps to expand and improve the sample of hospitals in NEISS are already underway. Both NEISS and NEDS (and the state databases from which NEDS draws) characterize *all* injuries by intent type, not just firearm injuries. This is important when evaluating whether changes in rates of assaults or self-harm are specific to firearms or apply to other methods as well. The purpose of preventing firearm injuries, after all, is to bring down the overall toll of violence and suicide.

Ideally, surveillance systems provide timely data. “Timely” is relative. For chronic disease, for example, annual reporting may be adequate, while for infectious disease, near real-time reporting is necessary. NEDS and NEISS report data out annually and have a one to three year reporting lag. CDC’s Len Paulozzi, former science officer at the NVDRS, has said that using sluggish systems like these for prevention efforts is like “trying to hit a tennis ball last seen two years ago.” The FASTER program, using continuous data uploads from the NSSP, could make near real-time firearm injury surveillance a reality. While FASTER may solve the need for timely

⁵ The term “surveillance” is used differently in the public health field than in the public safety field. It is not about covertly gathering data on individuals for enforcement purposes. It’s about openly gathering information on populations to track the incidence and characteristics of health problems for prevention and treatment purposes.

data, the other two systems supply more detailed and—especially in the case of NEISS—quality-controlled data.

Tracking Emergency Department-Treated Firearm Injuries: Three U.S. Data Systems

	NEDS	NEISS	FASTER/NSSP
Title	NEDS and SEDDs, SIDs	National Electronic Injury Surveillance System	Firearm Surveillance Through ERs, from NSSP
Sponsor	NEDS: HCUP, a project of the federal Agency for Healthcare Research & Quality SEDDs/SIDs: State health departments, hospital associations, or public/private consortia. Underlying data: individual hospitals' proprietary data.	Consumer Product Safety Commission. CDC's National Injury Prevention and Control Center collaborates with Consumer Product Safety Commission (CPSC) to gather data on all injuries, including more detailed data on firearm-related injuries.	FASTER (Firearm Surveillance Through ERs): CDC's National Center for Injury Prevention & Control NSSP: CDC's Division of Health Informatics and Surveillance Underlying data: individual hospitals' proprietary data.
Scope of system	All ED visits (medical, psychiatric, injury)	First time visits for injuries treated in the ED	All ED visits (medical, psych, injury)
Data entered by	Medical records coders review and code charts for hospital billing purposes	Abstractors under CPSC/CDC purview review charts and enter data; coding of intent overseen by a small number of coders at CDC based on reading brief narratives describing incident	Electronic health record data (presenting complaint, coded diagnoses, triage notes, and patient demographics) for all ED visits are automatically uploaded from participating hospitals' records to CDC BioSense platform
Representativeness	NEDS: National and four regions only SEDDs/SIDs: State and local	National only	Neither currently; potential for national, state, and local
Census or sample	NEDS: Sample (~1,000 hospitals) SEDDs/SIDs: Census	Sample (~100 hospitals)	Census among participating hospitals; NSSP currently neither census nor representative sample nationally
Reporting lag	2-3 Years	1-2 Years	Info: 1-2 Days Reports: Quarterly in FASTER

	NEDS	NEISS	FASTER/NSSP
Title	NEDS and SEDDs, SIDs	National Electronic Injury Surveillance System	Firearm Surveillance Through ERs, from NSSP
Reasonably accurate estimates of overall counts?	Yes	No Expected to be by 2022.	Unknown (likely Yes) Evaluation underway
Reasonably accurate classification of intent (e.g., assault, accident)?	No Far too many intentional firearm injuries classified as accidents	Yes	Unknown (likely No) Evaluation underway
Details on shooting circumstances?	No	A few	No
Aggregate firearm data searchable by the public online?	Yes Via HCUP-Net, but not user-friendly and only pre-2015	Yes NEISS-AIP available from the WISQARS-Nonfatal Injury Platform	Not yet
Researchers can apply for individual-level data?	Yes, but expensive NEDS via HCUP SEDDs via HCUP and states	Yes, free NEISS-FISS via Inter-University Consortium for Political and Social Research (ICPSR) website	Not yet
STRENGTHS	In 47 states today, SEDDs/SIDs provide a census of state and local ED-treated firearm injuries. Data from many of these states are centralized by HCUP, and HCUP creates stable national estimates drawn from close to 1,000 hospitals. It is likely this will eventually become a 50-state system.	Classification of intent in NEISS is reliable. Data are accessible on a convenient online data-query interface at the WISQARS-Nonfatal Injury Data Platform.	Huge strength is near real-time data. Currently data from hospitals seeing over 70% of ED visits nationally are uploaded to the NSSP platform. A current CMS initiative would boost that to close to 100%.
FLAWS	<i>Far</i> too many assaults are misclassified as accidents, seriously compromising an otherwise valuable data source. Also, data are difficult to access and expensive to buy.	Provides only national—not state or local—data. Small sample size and extreme geographic clustering of gunshot wounds leads to imprecise estimates. Annual changes in case estimates can be an artifact of individual hospitals entering or exiting the sample.	FASTER is very new; whether it can use NSSP to accurately detect and classify firearm injuries is currently unknown. Also, CDC has authority to access aggregate data from NSSP at national and regional level only, not more granular level (state, local, individual), with certain exceptions.

	NEDS	NEISS	FASTER/NSSP
Title	NEDS and SEDDs, SIDs	National Electronic Injury Surveillance System	Firearm Surveillance Through ERs, from NSSP
RECOMMENDATIONS	<p>A team investigating the intent classification problem will propose changes in coding guidance to the March 2022 meeting of the NCHS/CMS ICD-10 Coordination and Maintenance Committee (which governs ICD coding policy). If a new policy passes, use federal resources to:</p> <ul style="list-style-type: none"> Publicize the change to relevant professional associations (e.g., American Academy of Professional Coders, the American Hospital Information Managers Association). Work with companies that design coding software, coding look-up tables, and electronic health records software to improve intent classification. Educate researchers and journal editors on the intent classification problem. Evaluate the proportion of hospital-treated firearm injuries that receive a) any firearm injury-related e-code, b) the appropriate intent code (assault, accident, etc.). Create a user-friendly data-query interface to access injury data at national level and at state/local level in states that contribute SEDDs/SIDs. 	<ul style="list-style-type: none"> Support CSPC and CDC’s new sample plan and expansion of the NEISS-AIP to all 100 NEISS hospitals. Fund CDC to maintain the full sample after FY22. Publicize the existence of the more detailed, individual-level NEISS data available to researchers from the NEISS-FISS. For WISQARS-Nonfatal users, provide a simple explanation geared for the non-statistician on how to interpret wide confidence intervals in the data. 	<p>If FASTER program proves successful:</p> <ul style="list-style-type: none"> Support near 100% participation of EDs in the NSSP. Fund CDC to expand FASTER to all states. Negotiate an agreement among CDC, the Council of State and Territorial Epidemiologists (CSTE), and NSSP Community of Practice Governing Board authorizing CDC or CSTE to 1) to make national data on firearm injuries available at the state and sub-state level on a public, online data querying interface with appropriate data confidentiality protections and 2) provide a mechanism for researchers to apply for access to individual-level data. Fund CDC or CSTE to create and maintain a data querying website and to provide dataset access and documentation.

The NEDS and Statewide ED and Inpatient Databases

Sponsored by: HCUP of the Agency for Healthcare Research and Quality and by the state organizations that assemble SEDDs and SIDs

Background and History

ICD Codes and Uniform Hospital Discharge Data

Hospital case mix databases, including the NEDS, SEDDs, and SIDs, are based on hospital billing data. After a patient leaves the hospital, medical records coders review the chart and use the ICDs^{vi} coding system to summarize the patient's diagnoses and the procedures and services the patient received. For injury visits, diagnosis codes describe the type of injury (e.g., laceration, fracture) and the body part involved. Injury diagnoses are accompanied by an "external cause" code (e-code), which describes both the mechanism by which the injury was inflicted (e.g., sharp instrument, firearm) and the intent underlying the incident (assault, accident, intentionally self-inflicted, legal intervention, terrorism, war operations, and undetermined).

The ICD coding system is updated every several years. One set of codes (ICD) is used by vital statistics registries for deaths, and a more expanded set (ICD-Clinical Modification, or ICD-CM) is used by healthcare organizations to capture the larger universe of nonfatal conditions. For injury deaths, the underlying cause of death on the death certificate must be an e-code describing the injury's external cause. For healthcare data on injury encounters, it is the opposite: the primary diagnosis *cannot* be an e-code; e-codes are auxiliary, non-reimbursable codes.

Statewide Hospital Databases are a Census of Patient Visits

In nearly every state, hospitals forward a de-identified version of their billing claims data to a statewide organization--usually the state health department but sometimes the state hospital association or a public/private consortium. These statewide databases date back to the 1970s when payors and health services planners began comparing hospitals' costs and quality indicators and called for comparability in hospital claims data. The first databases covered inpatient discharges only; over the decades, many states have added databases covering ED visits, observation stays, and ambulatory care surgeries. The databases became increasingly valued not only for services planning and cost comparison but for basic epidemiology and for measuring health outcomes.^{vii}

Statewide databases represent a census, not a sample, of visits to non-federal, acute care hospitals. Their data include patient demographics (including zip code of residence in many states), transfer status, hospital identifier, mode of arrival, diagnoses and e-codes, procedures, physician type, charges, expected payor, length of stay, and disposition. Combining the SEDDs

(which cover only treat-and-release cases and transfers) and with SIDs (which cover inpatient cases) nets a complete ED dataset. Data can be used to calculate population-based incident rates in most states using patient's county of residence.

HCUP and National Hospital Databases

Most states with statewide hospital databases both disseminate their own data locally and forward it to the HCUP at the federal Agency for Healthcare Research and Quality. HCUP uses these databases to construct the NIS and the NEDS.^{viii} Currently for NEDS, 39 states and the District of Columbia submit data. For NIS, all jurisdictions except Alabama and Idaho submit, and HCUP anticipates that Alabama will soon. NEDS is a stratified, single-stage cluster sample of hospitals constructed by categorizing hospitals according to five strata: geographic region, urban/rural location, teaching status, ownership, and trauma-level designation. There are a total of roughly 4,000 acute care, non-Federal hospitals in the nation. In 2019, 990 hospitals in 37 states submitted data on nearly 36 million ED visits of all types, from which HCUP projected total visits of over 143 million for the nation. HCUP makes individual-level NEDS data available to researchers for a fee (as well as the NIS and state-specific databases). It also disseminates aggregate state and national data via an online data-query interface (HCUP-Net).

E-Codes & Injury Surveillance

In the last quarter of the 20th century, after decades of decline in deaths from infectious disease, and with injuries the top killer of people under 40, state and federal public health agencies turned attention to preventing injuries, and the CDC established the NCIPC in 1992. Hospital databases were of limited utility in understanding the etiology of injuries at that time because e-codes were infrequently coded in claims data. Knowing, for example, the incidence of severe head injuries is of limited utility to injury prevention efforts without also knowing the extent to which those injuries were sustained in, say, unintentional motor vehicle crashes, firearm suicides, or blunt force homicides—information that e-codes provide. Therefore, a large focus of state and national injury prevention efforts in the 1990s and early 2000s was to boost hospitals' use of e-codes.^{ix} Many states mandated e-coding by law or regulation. Over time, e-coding rates improved greatly. By 2011, an HCUP analysis found that the mean e-code rate for inpatient datasets submitted by 47 states was 92 percent, and for ED databases submitted by 30 states was 94 percent.^x The two lowest were 71 percent (Indiana and Ohio).

Although e-codes are not reimbursable, they are now considered the professional standard for medical records coding. Software programs used by hospitals to improve coding speed and accuracy, such as 3-M's encoder software, produce an error message if coders enter an injury diagnosis without an accompanying e-code. Without the e-code, firearm injuries could not be identified in databases. E-codes also differentiate between handguns and various types of long guns, but the majority of gunshot wounds (65 percent in 2014)^{xi} are coded to "unspecified" firearm type. (The full list of e-codes for firearm injury is in Appendix 2.) Auxiliary e-codes classify the type of place where the injury occurred (e.g., street, school) and the broad type of activity in which the patient was engaged at the time (e.g., walking/running, sports). These are

frequently not coded or coded to unknown and have thus received little attention in injury surveillance research.

Evaluating Sensitivity and Accuracy of NEDS for Firearm Injury Surveillance

Given that the vast majority of nonfatal firearm injury victims are treated in the ED, and all EDs use a coding system that is capable of identifying them, a critical question is whether the system is in fact doing so accurately.

Sensitivity and Positive Predictive Value (PPV)

A database's "sensitivity" is the proportion of all true cases that it correctly identifies as cases. "Positive predictive value" is the proportion of encounters coded as cases that truly are cases.^{xii} True cases for our purposes are projectile injuries resulting from the discharge of a firearm. These are typically not difficult to identify in a chart because the patient's presenting complaint (e.g., "multiple GSWs," "shotgun wound") and clinical notes (e.g., "Through and through bullet wound to left shoulder") often explicitly mention the firearm's involvement. A few studies have evaluated the sensitivity or PPV of ICD-coded hospital data for firearm injury. A 2001 study in Washington state found that sensitivity for firearm injuries was 91.6 percent (61.1-98.7) and PPV was 93.8 (91.2 to 95.6).^{xiii} Another early investigation in Oklahoma in 1998 found a sensitivity rate of 81 percent in inpatient data and very high PPV.^{xiv} A study in Indianapolis found that while most nonfatal firearm injuries identified in police data were seen in the ED, a significant minority did not receive a firearm-related ICD code^{xv} (as noted previously, Indiana has one of the two lowest e-code rates in the country). If we assume that overall sensitivity of NEDS today in capturing firearm injuries is roughly 90 percent, and that 90 percent or more of firearm injuries are treated in the ED, it follows that 81 percent or more of firearm injuries will be captured by national ED data.

The Big Problem: Misclassification of Intent

One problem documented in an early study of hospital firearm e-coding and that continues today, is likely misclassification of intent in ICD-coded hospital data. As described below, at least three national data systems that record injury-related data with a focus on injury intent suggest that hospital case mix data (including NEDS and SEDDs/SIDs) classify far too few firearm injuries as assaults and far too many as accidents. The problem was first reported in 1998 when researchers in Massachusetts linked data from the statewide inpatient database to the state's Weapon Related Injury Surveillance System (WRISS⁶).^{xvi} Classification of intent in WRISS was previously evaluated by state health department personnel and found to be largely

⁶ WRISS is a system under which nurses, physicians, and/or clerks in the ED send reports to the police and state health department after treating a gunshot wound. The report form includes a checkbox for intent and space for a brief incident narrative. For quality control, health department personnel reviewed each report form to confirm the accuracy of the intent classification and, for a sample of cases, reviewed the original hospital chart as well.

accurate. According to WRISS, 5 percent of the firearm admissions were accidents, 81 percent were assaults, and the remainder were self-inflicted or undetermined. According to the linked e-coded inpatient data, however, 57 percent were accidents and 31 percent were assaults.

The distribution of firearm injuries by intent in NEDS also appears to over-report accidents (Table 1, next page). One way to test whether the NEDS distribution by intent is plausible, as well as to evaluate the accuracy of NEDS’ overall firearm injury estimate, is to estimate expected values for nonfatal cases based on deaths. We can do that by applying intent-specific Case Fatality Rates (CFRs) to firearm deaths. In injury surveillance, the CFR is the proportion of all injury incidents (fatal and nonfatal combined) in a given time period that are fatal incidents. If we know, for example, that for every one fatal firearm assault, there are roughly 4 nonfatal injuries from firearm assault, we can estimate nonfatal assault-related firearm injuries based on firearm homicides.

Table 1 compares NEDS estimates for 2016 with estimates based on applying CFRs to 2016 firearm deaths. (The CFRs used are drawn from data sources other than ICD-coded hospital data to avoid circularity. See Appendix 2 for methods and data sources.) Both CFR-based and NEDS-based estimates are remarkably similar for *overall* nonfatal firearm injuries (about 78,000). With 990 EDs contributing data, estimates in NEDS are reasonably stable (coefficient of variation for the firearms estimate is 8 percent). Where the two approaches differ dramatically is in distribution by intent, with half of the NEDS cases classified as accidents, compared with only 10 percent of the CFR-based cases.

Table 1. Firearm Deaths and Estimated ED-Treated Nonfatal Firearm Injuries, by Intent –U.S., 2016

	Deaths*	CFR [^]	Estimated Nonfatal Injuries			
			CFR-based		NEDS-based	
			n	col %	n	col %
Homicide/assault	13968	0.18	63,632	81%	33,356	43%
Suicide/self-inflicted	22938	0.85	4,048	5%	2,379	3%
Accident	495	0.06	7,755	10%	38,879	50%
Undetermined	300	0.15	1,700	2%	2,489	3%
Legal Intervention ^{^^}	957	0.41	1,377	2%	1,136	1%
Total	38658		78,512	100%	78,240	100%

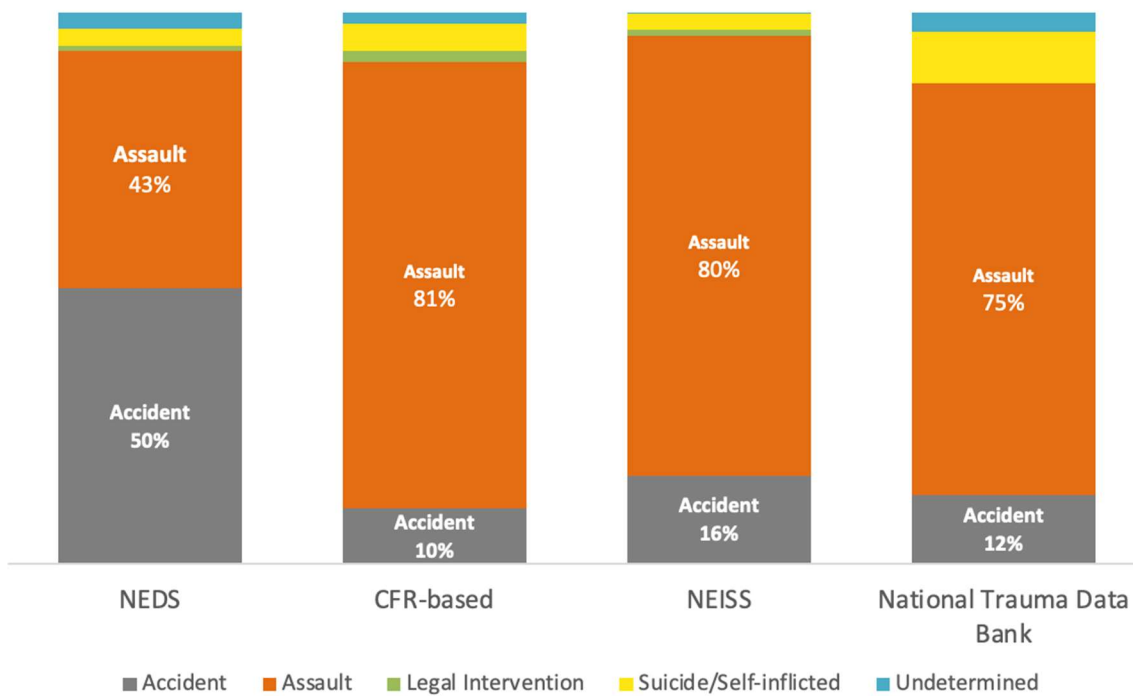
* **Deaths** are from Vital Statistics with one exception. Because Vital Statistics miss nearly half of legal intervention deaths,^{xvii} these deaths are from the *Washington Post*’s “Fatal Force” website, a validated data source,^{xviii} and homicides are adjusted accordingly. [^]**CFR**, or the proportion of all injury incidents (fatal and nonfatal combined) that are fatal. See Appendix 2 for CFR data sources.

Which Intent Distribution Is More Accurate: CFR-based or NEDS-based?

Figure 1 compares the distribution of nonfatal firearm injuries by intent from NEDS and CFR-based estimates with those from the NEISS (see section 2 on NEISS) and from trauma centers contributing to the National Trauma Data Bank.^{xix}

The NEDS distribution stands out as the outlier, while the other three (like the earlier WRISS study) indicate that assaults make up three-quarters or more of nonfatal gunshot wounds. Preliminary data from a chart review study currently in progress^{xx} also finds an intent distribution that aligns with the other data sources.

Figure 1. Distribution of intent classification for firearm injuries treated in the ED by data source. Data sources are for 2016 except from the National Trauma Data Bank, which is for 2010-2016.



What Accounts for the Intent Classification Problem?

One clear smoking gun is explicit coding guidance. In the U.S., a joint committee of the NCHS and the Centers for Medicare and Medicaid Services oversee ICD coding policies. Protocols in 1994 stated that in the absence of specific documentation in the patient’s chart to the contrary, injuries should be coded as accidents. In 1996, the guideline changed and called for injuries with unclear information as to intent should be coded as “undetermined whether accidentally or purposely inflicted.”^{xxi} The guidance changed again in October 2015, with the new ICD-10-CM release, returning to the pre-1996 position: “If the intent (accident, self-harm, assault) of the cause of an injury or other condition is unknown or unspecified, code the intent as accidental intent.”^{xxii}

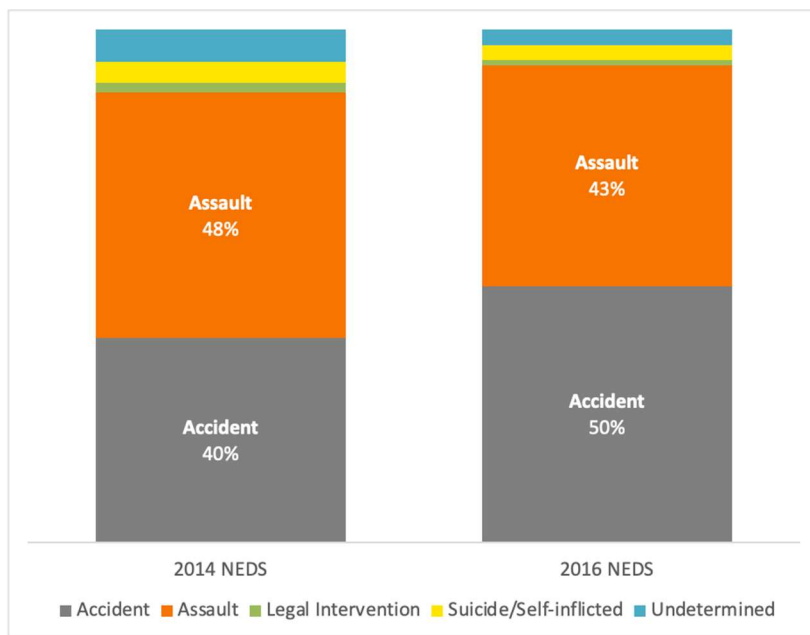
A reason for this guidance is to avoid overreliance on coding intent to unknown. Most injuries seen in the ED are accidental, but often neither the patient’s description of the incident nor the clinicians’ documentation explicitly state that. For example, in a medical chart that states, “Patient in a car crash 2 hours prior to arrival, complains of neck pain,” there is no indication whether the crash was accidental or intentional. However, accident is a good bet in the absence of evidence to the contrary. This is the case for many injury types (falls, motor vehicle crashes, burns, cuts) but not for gunshot wounds. A chart that says, “Patient sustained GSWs to left wrist and right shoulder; shot multiple times while he was walking down the street, did not recognize the shooter” again does not state intent, but in this case the chart is likely signaling an assault, not an accident.

Coding Guidelines Alone Do Not Explain the Problem.

ICD e-coding guidelines before 1996—like those after 2015—specified in effect that injuries should default to accident in the absence of evidence to the contrary. However, in the intervening years when that policy was not in effect, distribution by intent in NEDS (and other e-coded hospital data systems) still appeared to over-report firearm accidents, although not as dramatically. Figure 2 shows the distribution of nonfatal gunshot wounds by intent in the year before and the year after the coding guidance changed.

Figure 2. Distribution of nonfatal firearm injuries by intent and year, NEDS.

NB: In October 2015 new coding guidelines applied specifying that injuries with unknown intent be coded as accidents.



Potential sources of the problem are computer-assisted coding programs and look-up tables that steer users by default to e-codes in the unintentional range as well as coding training and

institutional custom. Whether, and the extent to which, each contribute to the problem is currently being investigated in a National Collaborative on Gun Violence Research (NCGVR) study.^{xxiii}

Data Access

HCUP provides free access to all of its data collections, including NEDS and many states' ED databases, via its online data querying website, HCUP-Net. The website is not well-suited to querying by external cause code and currently does not enable users to query by external cause beyond 2014. HCUP personnel state that they are working to resolve this. Individual-level datasets (both national and state-specific) are available to researchers for purchase and include excellent documentation. Costs, however, can be prohibitive at several hundred dollars per database per year, and not all states that have SEDDs and SIDs supply them to HCUP. States also make their own databases available to users, sometimes without cost.

Conclusion and Recommendations

NEDS and the statewide ED and inpatient databases on which NEDS is based are enormously valuable, providing investigators with data on the incidence of firearm injury at the national level (NEDS) and at the state and local level (individual states' SEDDs/SIDs). However, the databases currently provide a distorted picture of the circumstances under which these injuries occur. Recent peer-reviewed publications using these data have seriously mischaracterized the firearm injury problem as a result.^{xxiv,xxv,xxvi} This mischaracterization is an especially grave disservice to the communities that are most beset by firearm injury and could misdirect both funding priorities and outcome evaluations.

Steps can be taken over the next two years to solve the problem going forward:

The study team currently investigating source of the intent classification problem^{xxvii} will propose a change in coding guidance to the March 2022 meeting of the joint NCHS/CMS ICD-10 Coordination and Maintenance Committee (which governs e-code coding practices used in U.S. hospital billing data). If a new policy passes, we recommend that federal resources over the next year be used to:

- Publicize the policy change to relevant professional associations and their members who are responsible for coding and managing hospital data (e.g., American Academy of Professional Coders, the American Hospital Information Managers Association)
- Work with software companies that design coding software, coding look-up tables, and electronic health records software to ensure that artifacts of the software are not contributing to inadvertent classification of firearm injuries as accidents.

In addition, we recommend that federal resources be used to:

- Educate researchers, journal editors, and other stakeholders on the intent classification problem in current and past NEDS data and other e-coded hospital databases.
- Conduct studies of ICD-coded hospital databases evaluating: the proportion of hospital-treated firearm injuries that receive a) any firearm injury-related e-code, b) the appropriate e-code with respect to intent (assault, accident, etc.).
- Support the creation and upkeep of a user-friendly data-query interface that gives users access to aggregate national, state, and sub-state injury data based on NEDS and individual states' SEDDs and SIDs.

NEISS

Sponsored by: CPSC and CDC's NCIPC

Background and History

The CPSC has operated the NEISS since 1971 to collect data on product-related injuries treated in the ED.^{xxviii} NEISS is conducted in a stratified probability sample of U.S. hospitals that have over six beds and provide 24-hour emergency care. Over the years, the number of hospitals in the sample has hovered around 100 and is 90 today. The sample includes separate strata for very large, large, medium, and small hospitals, defined by the number of annual ED visits per hospital, and a separate stratum for children's hospitals. Data are collected by NEISS Coordinators at participating hospitals who review ED records for relevant injury visits and abstract data from patient charts.

Firearms are not regulated by the CPSC and as such were not included in the original NEISS scope of data collection. In 1993, CDC's NCIPC entered into an interagency agreement with CPSC to expand data collection to firearm injuries at all NEISS hospitals, establishing the NEISS-FISS.^{xxix} Data collected as part of NEISS-FISS include patient demographics, region of body injured, type of incident location, relationship of victim to shooter, intent (assault-related, legal intervention, self-inflicted, unintentional, and unknown), whether a crime or argument or gang activity was known to be involved, and disposition. De-identified individual-level data are archived on the University of Michigan's ICPSR data repository website and available for download. Documentation on weighting processes from which to make national estimates are provided there.

Starting in July 2000, CDC's Injury Center collaborated with CPSC on a second expansion to NEISS, the NEISS-AIP. From a two-thirds sub-sample of NEISS hospitals, data were collected on *all* injuries and poisonings, regardless of whether associated with a consumer product or a firearm. NEISS Coordinators abstract the data and provide a very brief narrative summarizing the cause of the injury. For quality control, a small number of centralized master coders read these narratives (and FISS narratives from non-AIP sites) to confirm the accuracy of the NEISS Coordinator's coding of intent and mechanism of injury.

Aggregate data from the All-Injury Program are available on CDC's user-friendly WISQARS data querying interface. To date, firearm injury data on WISQARS-Nonfatal Injury Data platform have been from the AIP two-thirds sample, not the full NEISS/NEISS-FISS sample.

The Problem of Unstable Annual Estimates

Given the small sample size for NEISS-AIP and wide variability in firearm injury caseloads at participating hospitals, annual estimates of firearm injuries have very wide confidence intervals

with Coefficients of Variation (CV) at 30 percent or higher in recent years (compared with 8 percent for NEDS). In the past, the WISQARS-Nonfatal website enabled users to see results on any data queries, including results with high CVs. Users could select the “advanced statistics” option which supplied Standard Error, CV, and confidence limits, to enable them to interpret the point estimates. Unstable estimates were asterisked, but visible to the user. This changed recently in response to a spate of media coverage highlighting the instability of the CDC’s nonfatal firearm estimates, and today the website will not show estimates for any injury type for which the CV is 30 percent or higher to prevent users without statistical training from misinterpreting the data (Figure 3).

Figure 3. Screen shot of WISQARS-Nonfatal output on estimated number of total nonfatal firearm injuries in the U.S., 2001-2019. Cells marked with an asterisk indicate Coefficient of Variation is 30 percent or higher.

Year	Estimated Number	Population	Crude Rate	Age-Adjusted Rate**	Number of Cases (Sample)	Standard Error	CV	Lower 95% Confidence Limit	Upper 95% Confidence Limit
2001	63,012	284,968,955	22.11	21.68	1,478	13,911	22.1%	35,747	90,278
2002	58,841	287,625,193	20.45	20.16	1,536	12,444	21.1%	34,451	83,231
2003	65,834	290,107,933	22.69	22.34	1,514	14,139	21.5%	38,122	93,547
2004	64,389	292,805,298	21.99	21.79	1,694	15,517	24.1%	33,976	94,802
2005	69,825	295,516,599	23.62	23.43	1,830	18,028	25.8%	34,490	105,160
2006	71,417	298,379,912	23.93	23.61	1,843	18,938	26.5%	34,299	108,535
2007	69,863	301,231,207	23.19	23.04	1,791	19,639	28.1%	31,370	108,355
2008	78,622	304,093,966	25.85	25.77	1,855	20,247	25.8%	38,938	118,306
2009	66,769	306,771,529	21.76	21.68	1,706	15,558	23.3%	36,275	97,262
2010	73,505	308,758,105	23.80	23.97	1,733	19,061	25.9%	36,146	110,864
2011	73,883	311,556,874	23.71	23.64	1,748	18,967	25.7%	36,708	111,058
2012	81,396	313,830,990	25.93	25.87	2,036	19,872	24.4%	42,446	120,345
2013	84,258	315,993,715	26.66	26.80	2,305	24,128	28.6%	36,968	131,548
2014	81,034	318,301,008	25.45	25.53	2,312	23,563	29.1%	34,850	127,219
2015	84,997	320,635,163	26.50	26.62	2,528	24,674	29.0%	36,636	133,357
2016	---	322,941,311	---	---	---	---	---	---	---
2017	---	324,985,539	---	---	---	---	---	---	---
2018	---	326,687,501	---	---	---	---	---	---	---
2019	---	328,239,523	---	---	---	---	---	---	---

Controversy over CDC Firearm Injury Estimates

In 2017, a paper appearing in the *American Journal of Epidemiology*^{xxx} reported a “hidden epidemic” of nonfatal, assault-related firearm injuries which increased during a time (2001-2013) when homicides had declined. An earlier commentary came to similar conclusions.^{xxxi} Both used data from WISQARS-Nonfatal but ignored the unusually broad confidence intervals surrounding the estimates and failed to whether characteristics of the underlying sample from which the estimates were drawn might be drawing the apparent “epidemic.”

Cook and colleagues^{xxxii} investigated the individual-level data in NEISS and rebutted the claims of an increase in nonfatal shootings.^{xxxiii} Two features of the data led to the seeming increase. First, there was a steady decline over the study period in NEISS coders' use of the "undetermined" category. Second, although hospitals typically stay in the NEISS sample for multiple years, some do leave. When they are replaced, the new hospital is recruited from the same sampling category as the exiting hospital with respect to overall ED patient volume and region of the country but not with respect to gunshot wound caseload. Two replacement hospitals (out of 15 total replacements) accounted for most of the apparent increase in firearm assaults across the entire roughly 100-hospital sample during the period. When adjusting for both the downward trend in use of "undetermined" and the hospital replacement issue, they found no increase in nonfatal firearm assaults, but instead a small decrease, mirroring homicide trends. They made no claims that their adjustments better approximated the true absolute rates or trends in firearm injury. Rather, their analysis demonstrated that the apparent increase in assaults in the NEISS data were artifacts of reporting. The adjusted trends they reported were supported by studies from the same time period using hospital inpatient data,^{xxxiv} trauma registry data,^{xxxv} and ED data,^{xxxvi} all of which showed no increase in nonfatal shootings.

The problems with the NEISS data drew a flurry of media attention critical of the CDC,^{xxxvii} leading Senator Bob Menendez (D-NJ) and 11 senators to send a letter to the Department of Health and Human Services raising concerns about the WISQARS-Nonfatal data and about federal capacity to track nonfatal firearm injuries.

The Geographic Clustering Problem

The problem at the core of using NEISS for firearm injury surveillance is that its sampling frame is designed to produce national estimates of ED injuries overall, not for any one specific injury type. For injuries as common as falls, which are seen in EDs at a rate of about 2,500 per 100,000 people in the U.S., and which are not expected to cluster geographically, the NEISS sample can be expected to deliver stable and relatively accurate point estimates each year. But at a rate of 27 per 100,000 people, firearm injuries are rare by comparison. And unlike most injury types, firearm injuries cluster dramatically not only in certain cities but in specific neighborhoods within those cities. Indeed, the clustering of nonfatal firearm injuries is so great that just 9 percent of the 953 hospitals in HCUP's NEDS sample in 2016 accounted for *two-thirds* of all firearm injury cases in unweighted data; 58 percent of the hospitals accounted for only 6 percent of cases.^{xxxviii} Clustering like this poses a major challenge to sample design.

The CDC/CPSC Plan to Improve NEISS-AIP

In 2019 the CPSC and CDC collaborated to improve the NEISS. CPSC awarded a contract to Westat, Inc. (CPSC contract 61320619F0134) to conduct an independent statistical analysis of the NEISS and NEISS-AIP samples and to recommend revisions to the sample frames to better meet injury data needs of both programs.^{xxxix} Westat weighed the advantages and drawbacks to retaining the existing sample, expanding it, or drawing a new sample. The company

recommended that 1) CPSC redesign the NEISS sample, retaining current hospitals when possible for stability and cost savings, and 2) immediately expand the NEISS-AIP data collection from its current two-thirds sample to the full NEISS hospital sample.

These recommendations address several concerns. First, the NEISS data frame had not been re-examined since it was last updated in the 1990s and many hospitals have closed, merged, or migrated across sampling strata in the interim. Second, the Office of Management and Budget was concerned about data accuracy and accessibility of the NEISS-AIP estimates. CDC’s decision not to display injury estimates with CVs of 30 percent or larger on the website led to suppressed data cells for firearm injuries and many other injury types, causing concern by users and reporters. Expanding AIP to the full sample is estimated to result in CVs of 16.7 percent^{xl} for firearm injuries and to improve reliability for several other injury types as well. At 16.7 percent, the confidence intervals will still be wide for firearm injuries but will be acceptable for release on WISQARS-Nonfatal. The new sample plan retains many of the existing NEISS sites but calls for recruiting 18 new sites.

Figure. 4. CPSC plan for new NEISS sample.

NEW NEISS SAMPLE						
Stratum	NEISS redesign	2021 NEISS: reporting (retained)	2021 NEISS: reporting (dropped)	2021 NEISS: replacements (retained)	2021 NEISS: replacements (dropped)	New
Small	43	30	0	8	3	5
Medium	26	14	1	1	0	11
Large	12	11	8	0	1	1
Very Large	11	9	0	2	0	0
Children's	8	7	1	0	0	1
Total	100	71	10	11	4	18

Source: Federal Register July 20, 2021;86(136):38315-8.

CPSC has filed the new plan on the Federal Register for public comment through September 21, 2021. The timeline for implementation is as follows:

- 2021 NEISS-AIP expands to the full current NEISS sample. This will likely lead to publishable firearm injury data for that data year and going forward.
- 2021 & 2022 CPSC and CDC recruit and train the new NEISS sample, adding 18 new sites for a total of 100. Data collection will continue in the old sample through 2023.
- 2023 Bridge year in which data are collected from both the old and new samples. This will accommodate time series studies that cross over the two NEISS samples and enable system designers to evaluate and adjust for impacts of the new sample on time trends.
- 2024 Official launch of the new sample only.

Ensuring Stability in Firearm Injury Caseload in Replacement Hospitals

Under the new plan, when a hospital of a given size stratum exits (due to closure, new management, etc.), care will be taken going forward to ensure that the replacement hospital is not only from the same size stratum and region of the country but has a firearm injury caseload similar to the one it replaces. This will improve the stability of the estimates and help ensure that changes in incidence rates reflect actual changes in cases, not changes in hospital sample composition.

The direct costs of paying NEISS contractors (abstractors) and hospitals for NEISS data totaled \$4,448,000 in 2019.^{xii} Expanding the AIP to the full NEISS sample is estimated at another \$650,000 in direct contractor and hospital costs. The CDC's NCIPC received funding in fiscal year 2021 to support the expansion of NEISS-AIP to the full NEISS sample but continued funding at the higher level to support the expansion has not been assured.^{xiii}

Data Access

NEISS data are highly accessible. The WISQARS-Nonfatal data querying website provides a user-friendly interface from which lay users can access aggregate NEISS-AIP data. Once the AIP data collection is expanded to the full NEISS sample, CDC expects that annual estimates of firearm injuries will no longer be subject to cell size suppressions due to wide confidence intervals. Individual-level data are available free to researchers from the ICPSR website, and datasets are well documented.

Conclusion and Recommendations

With only 100 hospitals contributing data, national estimates from NEISS of the overall count of firearm injuries are far more vulnerable than estimates from NEDS (with its nearly 1,000 hospitals) to the three pronged-problem of extreme geographic clustering of shootings, low actual base rate, and sampling error. However, the intent classification problem in NEDS and other e-coded hospital databases is a long-standing one and may prove difficult to fix. Intent classification in NEISS, on the other hand, is more reliable and has centralized quality controls. While the NEISS-estimated *numbers* of firearm injuries may continue to have wide confidence intervals, the *distribution* of firearm injuries by intent appears to be in the right ballpark, given its general concordance with the distribution found in National Trauma Bank data, CFR-imputed estimates, the WRISS study, and preliminary data from the current NCGVR-funded study. In addition, both NEISS and NEDS support a myriad of public health information needs on topics as diverse as pedestrian injury, intentional self-harm, and drug overdose. Improving both systems—NEISS as well as the hospital billing systems that feed into NEDS, SEDDs, and SIDs—is warranted.

We recommend the following steps to improve estimates of firearm injuries in NEISS:

- Support CSPC and CDC's new sample plan and expansion of the NEISS-AIP to all 100 NEISS hospitals and that hospitals that leave the system over time are replaced by hospitals with similar firearm injury caseloads as the existing hospital.
- Allocate funding to CDC to maintain the full sample after FY22. (Funds are already allocated to cover current year costs of recruiting and training new sites and collecting all-injury data at full sample.)
- Publicize the availability of the individual-level NEISS-FISS data to researchers.
- For users of CDC's WISQARS-Nonfatal data querying website, provide a simple explanation geared for the non-statistician on how to interpret wide confidence intervals in the data.

Firearm Surveillance Through Emergency Rooms (FASTER)

NSSP

Sponsored by: CDC NCIPC (FASTER); CDC Division of Health Informatics and Surveillance (NSSP)

Background and History

In response to the terrorist attacks of 2001, Congress directed the CDC to establish what is now called the NSSP to detect bioterrorism-related illnesses and other health issues.^{xliii} The system has since come to be used for purposes as diverse as detecting health impacts of oil spills, tracking the incidence of opioid overdose, and detecting clusters of carbon monoxide poisonings resulting from power outages. The purpose of syndromic surveillance is to detect in near real-time emerging health problems for mobilization of a rapid response that can reduce attendant harms.^{xliv} As such, these systems require active partnership and coordination across local, state, and national health agencies.

Currently participating hospitals account for 73 percent of ED visits nationally (Figure 3). Hospitals upload de-identified data from their electronic health information systems to state and local health departments or to data aggregators such as Health Information Exchanges.^{xlv} These local health agencies in turn contribute the data to the federal BioSense platform, where it is received typically within 24 or 48 hours of the ED visit; data are updated with new uploads. Information fields from EDs include chief complaint, free text triage notes (when available), diagnosis codes (when available, either in ICD or SNOMED-CT^{xlvi} codes⁷), patient characteristics, and location. EDs are not the only data source that NSSP uses, but we focus on them here given their relevance to firearm injury surveillance.

A Collaborative Model

In the early years of NSSP's development, CDC attempted to have facilities report data directly to the CDC but had trouble recruiting hospitals other than federal hospitals. The software was difficult to use and added little value at the state or local level. Recruitment improved greatly when CDC redesigned the system on a more cooperative model in 2010, relying in large part on state and local health departments to recruit hospitals, involving local stakeholders in designing a more user-friendly system, and providing useful analytic tools.

⁷ SNOMED-CT stands for "Systemized Nomenclature of Medicine—Clinical Terms." It is an international system available in multiple languages for standardizing and conceptually linking clinical terminology to assist in the exchange, processing, and communication of clinical information in electronic health records. It is governed by the International Health Terminology Standards Development Organisation (IHTSDO). See www.ihtsdo.org/

NSSP today relies on a “Community of Practice” model (coordinated by the CSTE via a cooperative agreement with the CDC) under which local, state, and national stakeholders work together to define an ever-expanding list of syndrome case definitions to track.^{xlvii} A syndrome may be, for example, health events as diverse as anthrax poisoning, a suicide attempt, or an adverse reaction to a specific vaccine. The CoP develops and shares algorithms (using coded data and in some cases artificial intelligence techniques) to identify health encounters that meet those case definitions. They improve the algorithms by testing their sensitivity and positive predictive power. The analytic software program that pulls cases that meet the syndrome classifications from the BioSense platform is ESSENCE (Electronic Surveillance System for the Early Notification of Community-based Epidemics).^{xlviii} ESSENCE provides users with tools to query and visualize the data. It also automatically detects and alerts users to potential adverse health events, employing a temporal alerting algorithm that uses a 30-day moving baseline to detect statistical anomalies.

The FASTER Program

In September 2020, the CDC’s NCIPC awarded a total of \$2.23 million to ten state health departments (DC, FL, GA, NM, NC, OR, UT, VA, WA, WV) to test using NSSP as a data source for nonfatal firearm injury surveillance. The goal of Firearm Surveillance Through Emergency Rooms (FASTER) is to enable state and local health departments to rapidly track ED-treated firearm injuries in near real-time, to classify them by intent, and to use the surveillance data to help communities most affected by gun injuries respond. In the program’s first year, participants have developed syndrome case definitions to identify first visits to the ED for injuries caused by firearm projectile and are currently validating how these definitions perform.

While it is too early in the new program to say for sure, FASTER personnel are optimistic that about their ability to capture overall counts of ED-treated firearm injuries using NSSP. They are less optimistic about the system’s ability to classify firearm injuries by intent. This is both because there is limited free text data uploaded to BioSense that describes the circumstances under which the shooting occurred from which to classify intent, and because any ICD “external cause” codes that accompany a case often misclassify intentional gunshot wounds as accidents (as discussed in the NEDS section). The fact that FASTER may be successful only in identifying firearm injuries overall and not in classifying intent is not necessarily a fatal flaw. Roughly three-quarters or more of ED-treated, nonfatal gunshot wounds are assaults. Spikes and dips in firearm injury patients are driven by assaults. Detecting volatility in near real-time at the local level is where NSSP excels. Data from more traditional systems, like NEDS and NEISS, are 1-3 years behind.

A recent project similar to FASTER, which utilized NSSP for opioid overdose surveillance, concluded that while traditional ICD-coded discharge data offered many strengths, rapid syndromic data was able to detect changes quickly to alert public health and safety personnel to remediable events, like local overdose clusters tied to shipments of illicit drugs with higher toxicity than normal.^{xlix}

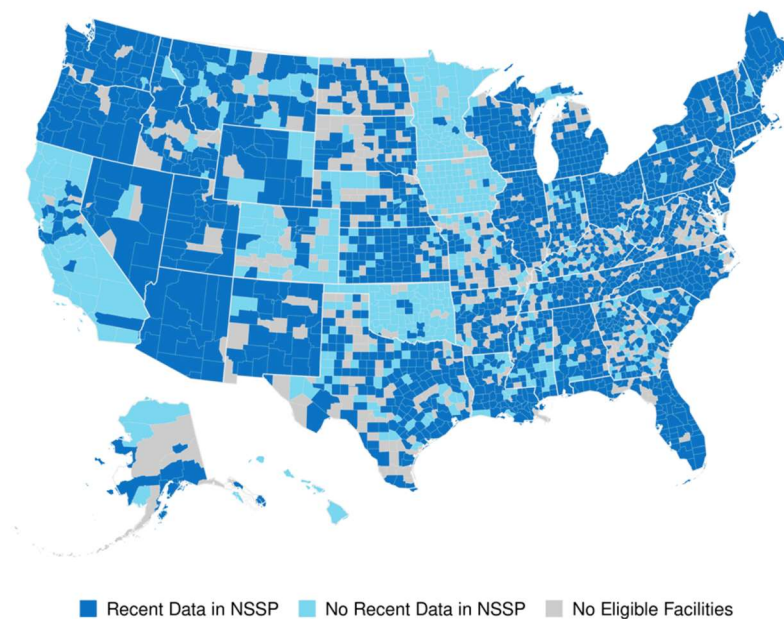
Federal Commitment

The NCIPC is committed to the FASTER program and to continuing to support state and local health departments in monitoring firearm injury in the most timely and accurate way possible. The Injury Center has received additional federal funding for firearm injury research, which can help support FASTER. The CDC's Division of Health Informatics and Surveillance has a strong commitment to expanding and improving NSSP, listing it as the second of its current (2019-2021) top four priorities.ⁱ

National Coverage

While the number of hospitals participating in NSSP is impressive, still one in four ED visits nationally is to a hospital that is not part of the system. Hospital participation is not randomly distributed. In six states (including California) very few hospitals participate (Figure 3). The Centers for Medicare and Medicaid Services in summer of 2021 passed a rule change (Federal Register, May 2021: 86 FR 25070) that requires acute care hospitals to participate in syndromic surveillance.ⁱⁱ The rule change (721 pages in length) covers an enormous range of topics, far beyond the syndromic surveillance requirement. The syndromic reporting expectation aligns with one of CMS's overarching goals, the Promoting Interoperability Program,ⁱⁱⁱ which spurs hospitals and selected providers to adopt electronic health records (EHRs). CMS, as well as the U.S. Department of Health and Human Services (HHS) more broadly, views adoptions of EHRs that can communicate across various platforms as key to improving health care in many areas, such as electronic prescribing for better accuracy and tracking, health information exchange across providers, patient/provider communication, patient access to health records, clinical decision support, payment reform, public health reporting, tracking for adverse events, and outcomes research.ⁱⁱⁱⁱ It appears likely that the impressive growth in the number of EDs participating in NSSP will likely continue to near 100 percent given the CMS rule change.

Figure 3. NSSP Participation, April 2020 – April 2021. Map identifies counties with at least one eligible facility that contributed at least one eligible record. (Map supplied by NSSP)



Data Access

The FASTER program’s benchmark is for states to share aggregate state and local data on a quarterly basis with local prevention partners. No plans have been announced to date whether individual-level data would be made available to researchers, and data dissemination is up to each individual state. While CDC’s Division of Health Informatics and Surveillance developed the architecture for NSSP, CDC has access to its data only at the aggregate national and regional level. Access to more granular state, local, and individual-level data is controlled by the facilities and health departments that submit the data. Exceptions are when CDC provides funding for state and local health departments to share their data or when CDC has received explicit permission from local partners for access to the more granular data for specified syndromes. Tracking trends at the national and gross regional level is useful. But shootings, like many other public health problems (overdoses, infectious disease outbreaks) often cluster geographically. Rates of violence across different cities can move in opposite directions, driven by local conditions (e.g., a high visibility police shooting, shifts in drug markets, gang truces, etc.). Lack of national oversight on local trends hobbles the capacity to identify local drivers across states or to act quickly to allocate resources to areas that need it. Without timely local data, research and resource allocation will continue to be driven not by the problems of today but problems as they existed two years ago.

That said, a lesson from NSSP’s early experience seemed to be that a simple top-down approach, with CDC calling the shots, was unsuccessful. Hospital recruitment and trust fared better under a more collaborative model under which power and control was shared across

institutional, state, and federal levels. A solution that retains a shared power model while enabling national investigators access to more granular data appears warranted. There are already models for this where data that is controlled at the local and state-level (mortality data, hospital case mix data, NVDRS data) are conveyed to a national center (NCHS, HCUP, and NCIPC, respectively) and made available via online data querying interfaces at the national, state, and sometimes local levels (CDC WONDER, HCUP-Net, CDC WISQARS, respectively). In addition, each has a mechanism by which researchers can apply for access to the individual-level data.

Conclusion and Recommendations

The FASTER pilot will likely establish that the NSSP is capable of efficiently delivering near real-time surveillance of firearm injuries, even if it is unable to successfully classify these events by intent type. The federal government is committed to NSSP, and the system's growth from currently capturing over 70 percent of ED visits to capturing nearly all seems likely in the next few years, given the recent CMS rule change^{liv} requiring EDs to participate in syndromic surveillance. While NSSP offers an extraordinary timeliness advantage over NEISS and hospital case mix data, if it can supply data only at the aggregate national and HHS regional levels and depends only on a state-by-state approach to making state and local aggregates available, the system will be far less useful and informative than it could otherwise be.

If the FASTER program proves successful over the next year, we recommend the following steps to support firearm injury surveillance in NSSP should the FASTER pilot prove successful:

- Support near 100 percent participation of EDs in the NSSP, via the current CMS rule change and/or other—especially incentive-based—means.
- Negotiate an agreement among CDC, the CSTE, and the NSSP Community of Practice Governing Board authorizing CDC or CSTE to 1) to make national data on firearm injuries available at the state and sub-state level on a public, online data querying interface with appropriate data confidentiality protections and 2) provide a mechanism for researchers to apply for individual-level data, again with appropriate confidentiality protections.
- Provide funding to the CDC or CSTE to create and maintain the data querying website and to provide dataset access and documentation to researchers.
- Provide funding to the CDC to expand FASTER to all states.

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Sources and methods for calculating intent-specific Case Fatality Rates for firearm injuries

List of firearm injury-related ICD-codes

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Appendix 1

Sources and Methods for Calculating Intent-specific CFRs for Firearm Injuries

The body of this report presented the table below. Described here are 1) the rationale for estimating nonfatal injuries based on deaths and 2) the data sources used in the table for both the deaths and intent-specific CFRs.

Table 1. Firearm Deaths and Estimated ED-Treated Nonfatal Firearm Injuries, by Intent –U.S., 2016

	Deaths*	CFR [^]	Estimated Nonfatal Injuries			
			CFR-based		NEDS-based	
	n		n	col %	n	col %
Homicide/assault	13968	0.18	63,632	81%	33,356	43%
Suicide/self-inflicted	22938	0.85	4,048	5%	2,379	3%
Accident	495	0.06	7,755	10%	38,879	50%
Undetermined	300	0.15	1,700	2%	2,489	3%
Legal Intervention ^{^^}	957	0.41	1,377	2%	1,136	1%
Total	38658		78,512	100%	78,240	100%

* **Deaths** are from Vital Statistics with one exception. Because Vital Statistics miss nearly half of legal intervention deaths,^{lv} these deaths are from the *Washington Post's* "Fatal Force" website, a validated data source,^{lvi} and homicides are adjusted accordingly. [^]**CFR**, or the proportion of all injury incidents (fatal and nonfatal combined) that are fatal. See Appendix 2 for CFR data sources.

Estimating Nonfatal Injuries from Deaths

Roughly one out of every five shooting assault victim dies. That's a CFR⁸ of about 20 percent. In a country with, say, 14,000 firearm homicides in a year, one can estimate that hospitals see about 70,000 nonfatal shooting assault victims ((14,000/.20) – 14,000). If in fact the actual CFR for gun assaults is as high as 25 percent or as low as 15 percent, the range of estimated nonfatal injuries will be 56,000 to 93,333. One's ability to project nonfatal injuries depends on having a good fix on the number of deaths and a good fix on the CFR, not just for assaults and homicides, but for each intent type.

⁸ The term CFR is defined differently in injury surveillance than in traditional disease surveillance. In disease surveillance it refers to the proportion of people with a given condition who die from that condition over a specified time period such as one month or five years or ten years. In injury surveillance, it refers to the proportion of acute injury incidents in a given time period (usually a year) that are fatal incidents.

Reliable Death Counts

Table 1 uses deaths from the National Vital Statistics System (NVSS) with one exception. Because close to half of legal intervention deaths are missed by Vital Statistics and are classified instead as homicides,^{lvii} legal intervention deaths for 2016 come from the *Washington Post's* Fatal Force website, a database that has been validated against the NVDRS and other databases.^{lviii} Homicides are adjusted accordingly. Firearm accidents are also frequently misclassified in Vital Statistics, according to a study using NVDRS data.^{lix} Errors varied a great deal across states with some over- and others under-reporting accidents. However, summed across states, the numbers amounted basically to a wash, so Table 1 uses the total number from Vital Statistics.

Reliable CFRs

To avoid circularity, the CFRs in Table 1 do not come from ICD-coded hospital data. Rather, they come from Massachusetts' WRISS and from police data. Massachusetts law requires hospitals to notify police when they treat a gunshot wound of any type, and these reports are the basis for WRISS. In the mid-1990s, state health department personnel conducted regular record reviews at all acute care hospitals in the state to determine the proportion of gunshot wounds that were successfully reported to the system and to test for reporting biases. WRISS published CFRs by intent type and demographic group using death certificates for deaths and hospital reports for nonfatal firearm injuries, adjusting for hospital under-reporting.^{lx} Table 1 uses WRISS CFRs with two exceptions. The CFR for firearm accidents in the published WRISS table was 4.5%; however, WRISS noted that four deaths that were classified as homicides on the death certificate were accidents according to the ED and media reports (e.g., two boys playing with a gun). Reclassifying these as accidents bumped the CFR to 6.1 percent. The WRISS CFR for assaults was 17.6 percent, which is well in line with published reports using police data, including both current (17.9 percent)^{lxi} and older (13-17 percent) data.^{lxii}

WRISS did not use a separate category for legal intervention incidents, including them instead in the assault/interpersonal violence category. Table 1 therefore uses a CFR drawn from police data. In 2017, the news source VICE collected data on fatal and nonfatal shootings by police officers from the 47 largest urban police departments.^{lxiii} We downloaded data from the VICE website and excluded departments where unknowns for fatal/nonfatal status were 25 percent or higher and departments that did not distinguish nonfatal injuries from subjects who were shot at but not hit. This left a total of 2,883 police shootings from which deaths, nonfatal injuries and misses could be identified. Among these, there was a 23 percent miss rate. Among hits, 41 percent were fatal, the CFR used in the table above.

While Table 1 projects very specific numbers, readers should understand that if the true value for the CFRs is somewhat higher or lower than those used here (which could well be the case), estimates will vary.

Appendix 2

Relevant ICD External Cause-of-Injury Codes for Firearm Injuries (Excluding War Operations)

ICD-9-CM Codes (for Cases Discharged Before October 1, 2015)

Assault, Terrorism

- E965.0 - Assault by handgun
- E965.1 - Assault by shotgun
- E965.2 - Assault by hunting rifle
- E965.3 - Assault by military firearms
- E965.4 - Assault by other and unspecified firearm
- E979.4 - Terrorism involving firearms

Self-inflicted

- E955.0 - Suicide and self-inflicted injury by handgun
- E955.1 - Suicide and self-inflicted injury by shotgun
- E955.2 - Suicide and self-inflicted injury by hunting rifle
- E955.3 - Suicide and self-inflicted injury by military firearms
- E955.4 - Suicide and self-inflicted injury by other and unspecified firearm
- E955.9 - Suicide and self-inflicted injury by firearms and explosives, unspecified

Unintentional

- E922.0 - Accident caused by handgun
- E922.1 - Accident caused by shotgun
- E922.2 - Accident caused by hunting rifle
- E922.3 - Accident caused by military firearms
- E922.8 - Accident caused by other specified firearm missile
- E922.9 - Accident caused by unspecified firearm missile

Legal intervention

- E970 - Injury due to legal intervention by firearms

Undetermined

- E985.0 - Injury by handgun, undetermined whether accidentally or purposely inflicted
- E985.1 - Injury by shotgun, undetermined whether accidentally or purposely inflicted
- E985.2 - Injury by hunting rifle, undetermined whether accidentally or purposely inflicted
- E985.3 - Injury by military firearms, undetermined whether accidentally or purposely inflicted
- E985.4 - Injury by other and unspecified firearm, undetermined whether accidentally or purposely inflicted

B. ICD-10-CM Codes (for cases discharged on or after October 1, 2015)

For the following, the 7th character refers to episode of care (A, D, S – initial, subsequent, and sequela). The use of “X” in the last or next-to-last character is used here to indicate any value, including missing. For surveillance of the incidence of firearm injury *events*, exclude cases where 7th character is D or S, and include those where it is A or missing. For surveillance of, say, overall burden of firearm injuries, use all.

Assaults, Terrorism

- X93XXX Assault by handgun discharge
- X940XX Assault by shotgun
- X941XX Assault by hunting rifle
- X942XX Assault by machine gun
- X948XX Assault by other larger firearm discharge
- X949XX Assault by unspecified larger firearm discharge
- X958XX Assault by other firearm discharge
- X959XX Assault by unspecified firearm discharge
- Y384X1 Terrorism involving firearms, public safety official injured
- Y384X2 Terrorism involving firearms, civilian injured
- Y384X3 Terrorism involving firearms, terrorist injured

Self-inflicted

- X72XXX Intentional self-harm by handgun discharge
- X730XX Intentional self-harm by shotgun discharge
- X731XX Intentional self-harm by hunting rifle discharge
- X732XX Intentional self-harm by machine gun discharge
- X738XX Intentional self-harm by other larger firearm discharge
- X739XX Intentional self-harm by unspecified larger firearm discharge
- X748XX Intentional self-harm by other firearm discharge
- X749XX Intentional self-harm by unspecified firearm discharge

Unintentional

- W320XX Accidental handgun discharge
- W321XX Accidental handgun malfunction
- W3300X Accidental discharge of unspecified larger firearm
- W3301X Accidental discharge of shotgun
- W3302X Accidental discharge of hunting rifle
- W3303X Accidental discharge of machine gun
- W3309X Accidental discharge of other larger firearm
- W3310X Accidental malfunction of unspecified larger firearm
- W3311X Accidental malfunction of shotgun
- W3312X Accidental malfunction of hunting rifle
- W3313X Accidental malfunction of machine gun
- W3319X Accidental malfunction of other larger firearm
- W3400X Accidental discharge from unspecified firearms or gun
- W3409X Accidental discharge from other specified firearms
- W3410X Accidental malfunction from unspecified firearms or gun
- W3419X Accidental malfunction from other specified firearms

Legal Intervention

- Y35001 Legal intervention by unspecified firearm discharge, law enfor. official injured
- Y35002 Legal intervention by unspecified firearm discharge, bystander injured
- Y35003 Legal intervention by unspecified firearm discharge, suspect injured
- Y35009 Legal intervention by unspecified firearm discharge, unspec'd person injured
- Y35011 Legal intervention by machine gun, law enforcement official injured
- Y35012 Legal intervention by machine gun, bystander injured
- Y35013 Legal intervention by machine gun, suspect injured
- Y35019 Legal intervention by machine gun, unspecified person injured
- Y35021 Legal intervention by handgun, law enforcement official injured
- Y35022 Legal intervention by handgun, bystander injured
- Y35023 Legal intervention by handgun, suspect injured
- Y35029 Legal intervention by handgun, unspecified person injured
- Y35031 Legal intervention by rifle pellet, law enforcement. official injured
- Y35032 Legal intervention by rifle pellet, bystander injured
- Y35033 Legal intervention by rifle pellet, suspect injured
- Y35039 Legal intervention by rifle pellet, unspecified person injured
- Y35091 Legal intervention by other firearm discharge, law enforcement official injured

Y35092 Legal intervention by other firearm discharge, bystander injured

Y35093 Legal intervention by other firearm discharge, suspect injured

Undetermined

Y22XXX Handgun discharge, undetermined intent

Y230XX Shotgun discharge, undetermined intent

Y231XX Hunting rifle discharge, undetermined intent

Y232XX Military firearm discharge, undetermined intent

Y233XX Machine gun discharge, undetermined intent

Y238XX Other larger firearm discharge, undetermined intent

Y239XX Unspecified larger firearm discharge, undetermined intent

Y248XX Other firearm discharge, undetermined intent

Y249XX Unspecified firearm discharge, undetermined intent

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