NORC at the University of Chicago

FINAL REPORT

OCTOBER 2021

Improving Data Infrastructure to Reduce Firearms Violence

Chapter 4. Studying Firearm Fatalities Using the NVDRS

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Synopsis

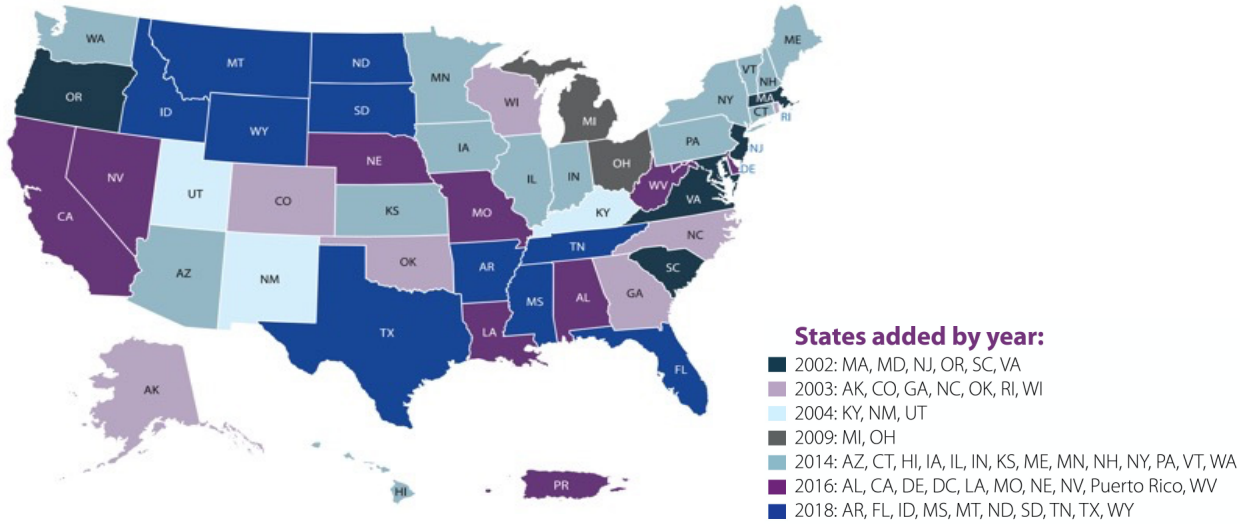
The NVDRS is the nation's primary source of public health information on fatalities resulting from violence, including firearm-related fatalities. The purpose of this chapter is to briefly review the methodology of NVDRS, examine trends in the research produced using the NVDRS, and recommend strategies for increasing the quantity and quality of NVDRS-related research.

NVDRS is a mature surveillance system for deaths from violence. It provides researchers with a unified data resource that combines death investigation information from medical and legal systems into a single national database.[1] There has been a recent surge in the number of studies that use NVDRS data. This is a positive trend that should be fostered.

NVDRS is a secondary surveillance system that utilizes pre-existing records. For this reason, the timeliness and quality of NVDRS data depend on the rigor of local death investigation practices. Unfortunately, medical and legal death investigation practices vary considerably among states. Thus, NVDRS would benefit from standardized metrics that quantify state-to-state variation in data quality and timeliness. More fundamentally, the nation would benefit considerably from increased rigor and standardization of local practices and policies for medical and legal death investigators.[2-6]

This chapter concludes with recommendations for strategies to further strengthen NVDRS and motivate researchers to use this unique data resource. Specifically, we recommend further support for NVDRS to: 1) incentivize, support, and expand the use of NVDRS data by researchers; 2) develop and release quality metrics for the system; and 3) strengthen the death investigation infrastructure that underpins the NVDRS.

Figure 1. Growth of the NVDRS. Source: U.S. Centers for Disease Control and Prevention, NCIPC.



History and Development of NVDRS

NVDRS is a key component in the nation's public health data infrastructure. Over its two-decade history, it has evolved from an initial sixteen-state system (established between 2002 and 2004) to become a nationally system that is the primary source of firearm fatality data.[1,7] The system began in the late 1990s and early 2000s, when visionary researchers at the Harvard Injury Control Center, with support from a group of private foundations, commissioned a national group of experts to refine their concept of a national system for data on violent deaths.[8]

Similar to many other CDC systems, NVDRS is supported and implemented on a state-by-state basis.[9] NVDRS was launched in 2002 with funding for six states (***Figure 1***). A total of 18 states were added through expansions in 2003, 2004, and 2009, bringing the total to 24 states.[8] The horrific mass casualty event at Sandy Hook Elementary School in 2012 led to renewed calls to scale the system to cover the nation. By 2018, NVDRS support had been expanded to include all 50 states, plus Puerto Rico and the District of Columbia.[10]

Overview of NVDRS Methodology

The NVDRS is a detailed and comprehensive source of data on firearm-related fatalities and other deaths from violence. The universe of deaths collected by NVDRS is comprised of all: a) homicides, b) suicides, c) deaths caused by law enforcement in the line of duty, and d) unintentional firearm deaths.[7] NVDRS complements the Bureau of Justice Statistic's NCVS, which is limited to nonfatal events. Each NVDRS event report includes a large number (over 600) of relational data elements that provide context for each death. The details collected

include the weapons involved, the relationships between the people involved, and the circumstances of death such as recent conflicts, crises, or life stressors.[7]

To develop and implement prevention strategies for violence, it is critically important to understand the relationships between the people involved.[1] NVDRS uses a data architecture that captures the personal relationships in each casualty event and the weapons used. Multiple individuals who died in the same event, and the firearms and other weapons used in the event, are linked together in a single database. This innovation allows researchers to conduct analyses that illuminate the etiology of fatal firearm violence.[10] For example, events in which a man murders his intimate partner and then kills himself can be readily identified using NVDRS; it is unique in linking suicides and homicides that are part of the same incident.[11-14] No other national data source on fatal violence captures these important relationships between events, people, and weapons for fatal violence.[1,6]

A key aspect of NVDRS is that it is a secondary surveillance system. This means that it use pre-existing sources of data only; no primary data collection (such as contact with next of kin) is involved.[9] NVDRS uses data abstractors in each state to extract information from the pre-existing records generated by the death investigation systems in each state. Information includes data from vital statistics, law enforcement, and coroners and medical examiners. Data are combined by NVDRS data abstractors in a systematic manner to provide a more complete picture of each violent death than would be obtained from any source in isolation.[7]

One disadvantage to the secondary surveillance system approach is the drawn-out nature of some death investigations. Typically, the most recent NVDRS data available to researchers is at least 2 years old. The other main disadvantage is the variability inherent in death investigation systems among states. The impact of these issues, and strategies for addressing them, are discussed in detail below.

State Variability in Death Investigation Systems

NVDRS combines pre-existing data sources and links them on a state-by-state basis, to a gap in our firearm violence data infrastructure[9] and provide a composite view of fatal violence across multiple medical and legal death investigation systems.[7,15] However, because it depends entirely on extant sources of information, NVDRS has brought into focus the limitations inherent in U.S. death investigation systems. These include the fragmented nature of our nation's medico-legal processes[2] and resultant heterogeneity in the quality of death investigation systems across the nation.[4]

Law enforcement response to an apparent death by violence varies considerably by local jurisdiction, the details of the event, and whether there is a perceived criminal intent. The priority of law enforcement is to establish the nature of the crime and, if relevant, apprehend perpetrators. Sharing data with public health professionals may vary by the perceived likelihood that a prosecution could be affected by such a collaboration. Variation by jurisdiction is

exacerbated by the fact that federal and state law enforcement typically adopt a weak stance to collaboration with other agencies and have done little to promote the integration of vital statistics and medical data into violence statistics.[15]

Medical response to violent death also varies considerably among states.[5] Prevailing medical death investigation practices in a specific locality depend on each state's requirements and current practices. They may also depend on the expertise and training of the certifying professional. In some rural areas, all death certifications may be done by only one or two providers. Most states require that local death investigations be conducted by medical professionals and have centralized state medical examiner systems that collate and review case reports. However, some states still permit elected non-medical professionals, known as coroners, to investigate and certify deaths. Irrespective of the medical background of the local examiner, investigation and certification of death is typically poorly compensated.[3]

To address these issues, CDC has implemented standard timelines for completing data acquisitions that are uniform across participating states. CDC has also implemented NVDRS quality control measures, including metrics to monitor data quality and blinded duplicate abstractions for a sample of cases in each state.[7] These are important and helpful advancements. However, national quality control procedures are not an antidote for the underlying problem of state-to-state variability in the quality of local death investigation systems.

As an example, a classic situation in medico-legal death investigation is the classification of a violent death as "Undetermined Intent," meaning that it is unclear if the death was a homicide or a suicide. Some deaths in this category result from areas of genuine uncertainty, such as a death in which a decedent appeared to deliberately provoke law enforcement agencies with apparent intent to be fatally wounded. Another ambiguity is a fatal single-vehicle crash that was preceded by repeated overt signs of suicide ideation and/or self-harm. Likewise, drug overdose deaths may reflect a complex etiology, sometimes including self-harm and crises, that can make determination of intent problematic.[16-18]

We acknowledge that there may be legitimate ambiguity in determination of intent. However, there is enormous state-to-state variability in the proportion of violent deaths that are classified by death investigators as belonging in the "Undetermined Intent" category. This variability is far too large to reflect regional variation in the incidence of truly ambiguous cases, such as those discussed in the preceding paragraph. Rather, it reveals the gross inconsistencies in death investigation practices among the states.

To illustrate how state-to-state variability in death investigation practices affects the NVDRS, we analyzed the proportion of "Undetermined Intent" deaths by state. We used 2018 NVDRS data, the most recent year NVDRS data are available. Our analysis used aggregated counts and was conducted using the NVDRS data publicly available on the CDC's WISQARS, an interactive user interface that provides customized reports of injury-related data. WISQARS enables the public to run custom table requests against NVDRS data. For more complex analyses, CDC

makes available a restricted access data (RAD) file, which can be obtained upon CDC receipt of a data request form.

CDC suppress small counts and totals based on small counts, to prevent deductive disclosure. For this reason, we defined a measure specific to this analysis, the "Undetermined Intent Ratio" (UIR), defined as 90 times the ratio of Undetermined Intent Deaths to the sum of the total homicides and suicides in each state. The sum of total homicides and suicides excludes unintentional firearm deaths, suicides preceded by a homicide, and legal intervention deaths, which are prone to CDC suppression for small counts. For most states, the UIR roughly approximates the proportion of violent deaths classified as undetermined intent.

Table 1. Analysis of Undetermined Intent Deaths by Jurisdiction, NVDRS 2018

UIR in the range 0.0 to 9.9	Alabama, Arizona, California, Colorado, Connecticut, Georgia, Illinois, Iowa, Kansas, Kentucky, Louisiana, Maine, Massachusetts, Minnesota, Missouri, Nevada, New Jersey, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Utah, Virginia, Washington, West Virginia, Wisconsin	n=28
UIR of 10.0 or greater; fewer than 100 Undetermined Intent Deaths	Alaska, Rhode Island, Vermont	n=3
UIR of 10.0 or greater; 100 or more Undetermined Intent Deaths	Indiana, Maryland, Michigan, New York	n=4
UIR not computed due to small numbers (<10 Undetermined Intent Deaths in 2018)	*Delaware, District of Columbia, Nebraska, New Hampshire, New Mexico*	*n=5*
Data not yet available via WISQARS (e.g. not funded to collect data in 2018)	*Arkansas, Florida, Hawaii, Idaho, Mississippi, Montana, North Dakota, Puerto Rico, South Dakota, Tennessee, Texas, Wyoming*	*n=12*

UIR is the ratio of Undetermined Intent Deaths to Total Homicides and Suicides Combined, multiplied by 90. Total homicides and suicides combined excludes unintentional firearm deaths, suicides preceded by a homicide, and legal intervention deaths.

In 2018, the NVDRS data available in WISQARS classified 8.8 percent of violent deaths as Undetermined Intent, which is high, but not untenable, from a research standpoint. However, there is considerable state-to-state variability, and it is notable that most deaths classified as Undetermined Intent come from a handful of "outlier" states.

Most of the states reporting to NVDRS had an acceptable proportion of violent deaths classified as Undetermined Intent (***Table 1***) as evidenced by a UIR below 10 (n=28 states). However, seven states had a UIR above 10, and four of these (Indiana, Maryland, Michigan, and New York) were large states with more than 100 violent deaths in 2018 classified as Undetermined Intent. These four states accounted for 58 percent of all Undetermined Intent Deaths recorded by the entire NVDRS system in 2018. Maryland alone (less than 2 percent of the U.S. population) accounts for over one-third of all Undetermined Intent Deaths in NVDRS. This is a frustrating situation, given that Maryland was one of the first states funded by NVDRS, and concerns about the Maryland data were noted as early as the mid-2000s.[5]

This example demonstrates that there is substantial local variability in the death investigation practices that generate the information that NVDRS uses. Clearly, it is hard to generate prevention strategies in the absence of basic information on Intent.

At time of writing, a total of 11 states and Puerto Rico did not have retrievable 2018 data in the WISQARS system (***Table 1***). This includes the states that were funded for the first time in 2018 and includes the large states of Florida and Texas, which are notable for their lack of centralized resources.

Strategies for Improving Death Investigation Systems

Over the past two decades, there have been repeated calls for progress towards strengthening the national standards for medico-legal death investigation, for example, in reports published by the National Research Council and the Institute of Medicine.[3,4] Two recent commentaries have called for improvements in national death investigation systems specifically in the context of NVDRS.[6,15] Kaplan et al.[6] advocate for improvements in death investigation systems so that all deaths from violence are "investigated, evaluated, and certified in the same way nationwide" with the goal of ensuring consistent NVDRS data.[6] They note that "NVDRS is limited by the assortment of medico-legal death investigation systems in the participating states," and lament "extreme variations" due to the "idiosyncratic assumptions" of some death certifiers.[6] Mays and Cochran[15] draw attention to decades of underinvestment in local death systems and stress the potential for technological innovations that would improve timeliness of local and national data systems.[15] They point out that investments in technology, and other improvements in our death data systems, have the potential to yield "near real-time system of mortality surveillance," thereby helping vital statistics fulfill "its public health function of being an early detector of emerging public health epidemics." [15] For example, in an ideal world, a system such as NVDRS would be able to detect, in a very timely manner, upticks in specific types of fatal violence because of macro forces such as the COVID-19 pandemic. Recommendation 2 presents a strategy for addressing the issue of timeliness (see below).

To date, the resources that have been channeled into establishing and growing the NVDRS have been public health resources.[6,10,19-22] In order for NVDRS to reach its full potential as a comprehensive and timely source for national statistics on violent deaths, our national and local law enforcement, justice, and medical examiner systems must commit to NVDRS's goals. This will involve a commitment to reforming local medico-legal death investigation procedures that are currently highly variable, fragmentary, and lack adherence to national standards.[2-4] Recommendation 5 presents specific strategies that would advance this goal (see below).

The development of NVDRS has influenced local death investigators to become more rigorous over time. For example, a detailed death investigation involving a firearm suicide typically would be of limited interest to law enforcement, beyond establishing that there was no perpetrator to apprehend. In some NVDRS states, such as North Carolina, the connection between public health and law enforcement created by NVDRS has meant that local law enforcement has

become more willing to collect and share data, once the importance of complete and timely reporting of violent deaths is fully understood. Ultimately, improvements in our medico-legal death investigation systems must occur at both the national and the local level.

Published Research Using NVDRS Data

A small literature review was conducted to understand how NVDRS is being used by researchers and to examine trends in use of the data. We searched PubMed using the terms "National Violent Death Reporting System" or "NVDRS" and reviewed all identified articles that were published prior to December 31, 2020. Published letters to journals were excluded unless they pertained directly to a published study in that journal (e.g., Letters to the Editor following a publication). This search located 223 articles. While not intended to be comprehensive, this small search was considered appropriate for analysis of trends and to characterize the extant NVDRS-related literature.

We categorized the publications retrieved in our search based on the presence of one or more of the following three attributes:

- Publications that used NVDRS data to publish original research findings. This group comprises both studies that used data from a single state and studies that used CDC's national RAD dataset, which CDC makes available to legitimate researchers (n=192).
- Methodologic research directly pertinent to NVDRS, such as evaluations of the system or details of statistical methods developed for use with NVDRS data (n=18).
- Commentaries, reviews, or editorials that described or publicized NVDRS, reviewed the methods and/or scope of NVDRS, or described and/or reviewed literature that used NVDRS data (n=17).

The three groups were exhaustive but non-exclusive (i.e., a study could be in more than one group). For example, a study that developed a new method, and applied it for the purposes of making scientific inference or descriptive analyses, would be counted in both group 1 and group 2 but would be counted only once in Figure 2.

Studies using NVDRS data have greatly deepened our scientific knowledge of violence. As noted above, NVDRS is unique among mortality databases because it captures data on the relationships between the people involved in the violence. Therefore, researchers have used the data to examine homicides resulting from intimate partner violence and situations in which homicides and suicides are linked.[11,13,23-31] NVDRS is a unique data resource for such analyses.

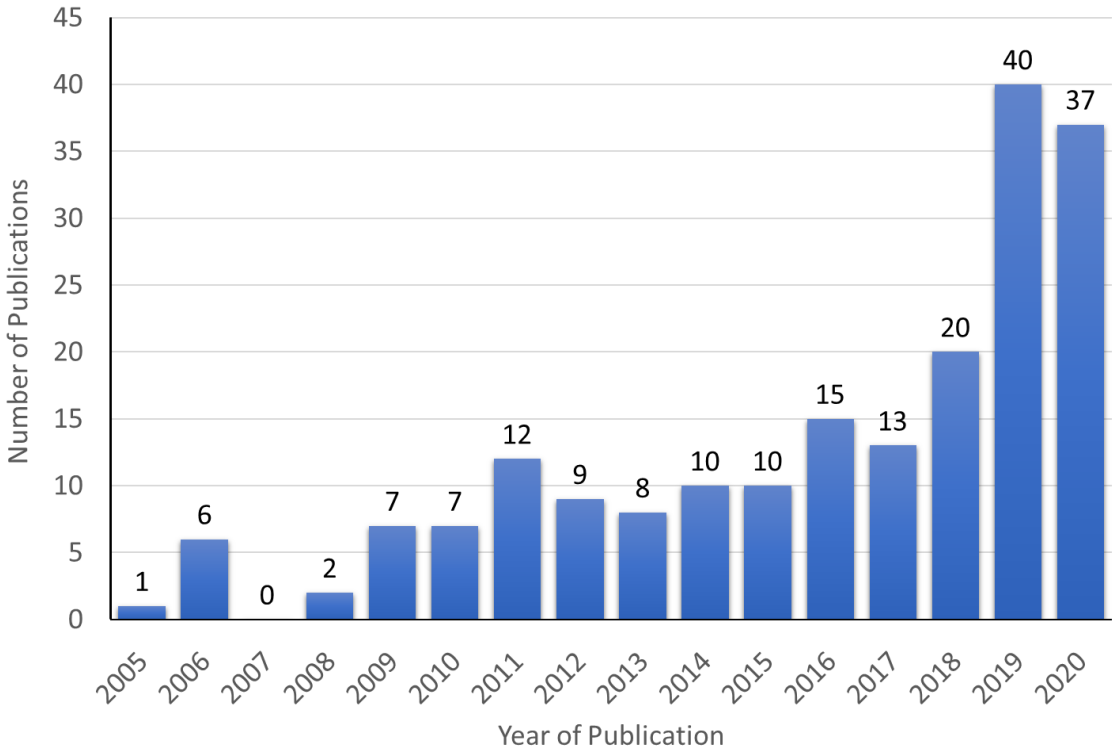
In additional, the large (and ever-growing) sample size of NVDRS has provided statistical power to examine violent deaths by subgroup, facilitating examination of violence among demographic subgroups such as children,[23,32-36] adolescents,[11,24,36-38] women,[29,30,39-45] older adults,[46-53] Hispanics,[54-56] LGTBQ+ groups,[57-59] and military/veterans.[60-69] Researchers have also used

NVDRS data to explore both the factors involved in homicides of civilians committed by law enforcement officers[70-73] and to examine homicides sustained by law enforcement officers.[74]

The majority of violent deaths in the U.S. involve firearms, and NVDRS captures details on all weapons involved. For this reason, an additional benefit of NVDRS has been the ability to characterize the toll of firearm violence in detail.[13,33,38,62,75-82] Of the articles that published original research findings using NVDRS data (n=192), a total of 83 (43 percent) mentioned firearms in the title, abstract, or keywords. Further, researchers have used NVDRS data to examine the impact of state-level firearm legislation on violent deaths.[14,83]

The number of research articles using NVDRS data has increased over time, with a steep surge in recent years (***Figure 2***). A preliminary review of 2021 publications indicates that the total number is likely to exceed that for 2020. The reasons for the recent surge in publications are not fully known but likely relate to the steady accrual of case numbers in the system over time and the increasing representativeness of the system as the number of states contributing data has grown. In addition, there is a growing understanding in the research community that some of the problems inherent in violence require population-based research using data sources such as NVDRS. There is increasing concern over the toll of violence in the U.S., so all these factors will likely continue to intensify over time. Now is an important time to implement strategies to support (and further increase) the use of NVDRS data by researchers. Recommendation 1 presents strategies for addressing this topic (see below).

Figure 2. Publications Using NVDRS Data



Methodologic Research

As noted above, this review identified 18 papers discussing methodologic aspects of NVDRS and/or the data generated from the system. However, relative to other public health surveillance systems, there is little information on data quality in NVDRS. The literature (and extensive CDC documentation) lacks information on data quality measures. Specifically, there is little methodological research into statistical strategies to address known deficiencies and issues in the death investigation systems that underlie NVDRS.

Other large-scale federal surveillance efforts of similar scope have been able to invest in the development and application of advanced statistical methods. One point of comparison is the Fatal Analysis Reporting System (FARS), the national surveillance system for fatal motor vehicle crashes. FARS makes extensive use of the statistical technique of imputation to address known problems, such as incomplete alcohol and drug testing data from some states. The initial development of statistical methods to apply this technique to FARS alcohol data was supported by the federal agency that operates FARS (the National Highway Traffic Safety Administration).[84,85]

The NVDRS methodologic literature does not include contributions about using advanced statistical methods to address the timeliness and data quality issues that stem from the patchwork nature of death investigation systems in the U.S. As an example of the type of research that is needed, consider the problem of suicides from drug overdose that are misclassified under other causes, such as Undetermined Intent.[5,17,18,86] A recent methodologic paper[87] developed a statistical method to address this problem. Liu et al.[87] used three years of data from Utah to train a machine learning algorithm to recognize suicides from drug overdoses that were misclassified as Intent Undetermined deaths.[87] They estimated that drug overdose suicides in Utah are underreported by up to 33 percent, resulting in an overall undercount of all suicides in Utah by nine percent.[87]

Machine learning techniques, such as those used by Liu et al.[87] may be applied to NVDRS data in many ways. For example, they have potential to address the problem of outlier states (Indiana, Maryland, Michigan, New York) that are responsible for the majority of “Intent Undetermined” deaths nationally (***Table 1***). Another example is the potential to use machine learning techniques to facilitate release of timely provisional aggregate statistics on deaths from violence. This would allow NVDRS to generate sentinel advance reports to provide policymakers and researchers with timely provisional information on trends. This cost-efficient short term strategy would complement the long-term strategies of reforming local medical-legal processes across the nation. Recommendations 3 and 4 present specific strategies to advance methodologic research that would address data quality issues that result from variability in our nation’s death investigation systems (see below).

Recommendations for Increasing the Use of NVDRS by Researchers

This section provides a set of recommendations for increasing the quantity, quality, and impact of scientific research that uses NVDRS data. These recommendations contain strategies to strengthen the rigor, sophistication, and timeliness of research using NVDRS data.

Recommendation 1: Increase Support for Researchers Who Use NVDRS Data

It is important to ensure that there is a large and growing number of studies that use NVDRS data. To support an expanding pipeline of high-quality research products, we recommend establishing a national NVDRS research consortium dedicated to advancing the use of NVDRS data by the scientific community. The consortium would encourage new researchers to use NVDRS and assist existing NVDRS users in discovering new aspects of this unique data resource. In addition, the national consortium would be a forum to disseminate advanced statistical methods relevant to NVDRS data and innovative uses of NVDRS data. Some potential activities for this consortium are listed in ***Table 2***.

Fortunately, CDC has created a solid foundation for expanded efforts in this area. The agency has invested considerable efforts to make NVDRS data resources accessible to researchers. (When the author contacted CDC regarding access to the data, he was provided with a comprehensive and detailed set of data documents in less than 15 minutes). CDC also deserves much credit for developing and presenting learning academy workshops at national forums, such as the American Public Health Association. In addition, some states have developed regional workshops to showcase their state's NVDRS to local researchers. There is considerable scope for scaling up these efforts so that they have greater impact and build a large and diverse community of NVDRS scholars.

Table 2. Potential Activities of Proposed NVDRS Research Consortium

■ Maintain a list of published studies using NVDRS data
■ Identify key research questions that are amenable to NVDRS data
■ Maintain a list of databases that may be combined with NVDRS data to answer novel research questions
■ Plan an annual NVDRS research conference to build linkages between researchers
■ Provide technical support to emerging researchers, such as doctoral students and junior faculty, in using NVDRS data
■ Provide a forum for discussing advanced analytical approaches to NVDRS data

Recommendation 2: Improve Timeliness by Providing Provisional Data Releases

Violence is a dynamic and ever-evolving problem in the U.S. For example, the COVID-19 pandemic saw an escalation of firearm sales and an expansion of the demographic subgroups that typically purchase firearms. One concern is the modest pace at which detailed homicide and suicide data become available to researchers. NVDRS data files are typically finalized and made available to the researchers approximately two years after the violence occurred. The ability of researchers to monitor and respond to change is hampered by the time it takes to finalize NVDRS data. CDC has invested considerable efforts in ensure that complete data are acquired and finalized as rapidly as possible; the lag reflects the slow pace of local criminal justice and medico-legal death investigation infrastructure. CDC should provide more timely interim data releases of portions of the RAD file, as they become available. Interim releases could be limited to a subset of variables (i.e., the variables that are completed more rapidly by all states) or a subset of states (i.e., those geographic locations that generate high-quality data in the most rapid manner). If interim data releases were available, external researchers would be able to conduct data analyses limited to these variables or regions, noting that such work may not be nationally representative. Such a limitation is acceptable in exchange for more timely data, knowing that more complete datasets would become available in the future. As noted above, special statistical techniques, such as inverse probability weights, could be employed to address a lack of representativeness.

Recommendation 3: Develop and Release Indicators of NVDRS Data Quality

Researchers who use NVDRS data receive very limited information about data quality. CDC has implemented *internal* quality control measures, including a quality control dashboard and re-abstractions to monitor data quality.[7] However, indicators of data quality are not included on the files released to external researchers. Markers of data quality, by state and time period, should be derived by CDC and made available to researchers who use the RAD files. Such measures could be based on metrics such as the proportion of violent and firearm deaths classified as Intention Undetermined in each state (moving average over a three-year period), and/or completeness of the circumstances variables for suicides and homicides in a state (moving average over a three-year period). It takes time to establish NVDRS within a state, so such measures should be reported only for states that have moved beyond the initial phase of system setup (e.g., states that have been funded for three or more years). Further, the scientific literature contains only one formal evaluation of a state NVDRS system.[88] There is a need to conduct and publish more evaluations of the system, either nationally or state-by-state, as peer-reviewed manuscripts or technical reports.

Recommendation 4: Fund NVDRS Methodologic Research

Other large federal data collection systems, such as FARS (fatal motor vehicle crashes), have utilized statistical techniques such as multiple imputation to address data quality issues in their systems. Funding should be provided to researchers, via competitive mechanisms such as federal grants, to conduct methodological investigations into the use of advanced statistical techniques to address known limitations of the local death investigation systems that underlie NVDRS, such as data timeliness and variation in data quality. These techniques could include inverse probability weights, multiple imputation, and machine learning.

Recommendation 5: Strengthen the Death Investigation Systems That Underlie NVDRS

As noted above, NVDRS depends solely on pre-existing administrative records, such as law enforcement reports, medical examiner reports, and death certificates. Thus, the timeliness and quality of NVDRS data depends heavily on the local criminal justice and medico-legal death investigation systems that generate the records and reports abstracted by NVDRS coders. The recent advent of a nationwide NVDRS system has highlighted the variations in quality due to the lack of standardized procedures for local criminal justice and medico-legal death investigation. These systems include medical examiners' and coroners' reports, law enforcement investigations, justice procedures, and vital statistics registration. Many of these systems take considerable time to assemble complete data. Simply put, our nation's death investigation systems are a patchwork quilt. The completeness, timeliness, and variability of local criminal justice and medico-legal death investigation systems should be fully documented through an independent review conducted by a national agency such as NAS. Such a review should detail the impact of these local variations in procedures on NVDRS and similar national systems. It should also provide an opportunity to make recommendations about improving the uniformity and rigor of criminal justice and medico-legal death investigations. Identification of the localities with the most rigorous procedures would inform future investments in future data infrastructure and suggest the most promising locations to build surveillance systems for nonfatal violence.

Summary

NVDRS data is an invaluable source of data on deaths from violence. It is a unique resource that combines data from multiple sources into a comprehensive data resource that now includes all 50 states, plus the District of Columbia and Puerto Rico. The growth of NVDRS over the past two decades has led to an increase in number of published studies that use NVDRS data. There is ample scope for continued scaling up in the use of these data by researchers, and we provide strategies to facilitate that goal (Recommendation 1).

Because it relies on existing data sources, NVDRS depends on the timeliness and rigor of local death investigation practices, which vary markedly among states. To address data quality and timeliness, NVDRS should implement interim data releases of provisional statistics and data (Recommendation 2), the publication of standardized metrics to quantify state-to-state variation in data quality (Recommendation 3), and the development of statistical procedures to address the limitations inherent in our nation's death investigation systems (Recommendation 4). More fundamentally, both NVDRS and the nation would benefit from measures to strengthen the death investigation infrastructure and standardize it across jurisdictions (Recommendation 5).

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