Research utility of the National Violent Death Reporting System: a scoping review

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Abstract

Background: To better understand and prevent suicide and homicide, the National Center for Injury Prevention and Control of the US Centers for Disease Control and Prevention launched the National Violent Death Reporting System (NVDRS) in six states in 2002. As of 2018, the NVDRS has been expanded to include all 50 states, the District of Columbia and Puerto Rico. The purpose of this review was to assess the research utility of the NVDRS based on studies indexed in major bibliographical databases.

Methods: We performed a scoping review of published studies that were based on data from the NVDRS, identified by searching six electronic databases: PubMed, EMBASE, Google Scholar, OVID, Scopus, and Web of Science. We examined the time trend of annual NVDRS-based research output, generated a word cloud using the keywords listed in the publications, and mapped the knowledge domains covered by NVDRS-based studies.

Results: Our review included a total of 150 studies published between 2005 and 2018. There was a marked increase in the annual number of NVDRS-based publications, with 120 (80.0%) of the 150 studies published between 2011 and 2018. Overall, 104 (69.3%) studies focused on suicide and 39 (26.0%) on homicide. Of the included studies, 100 (66.7%) were descriptive epidemiology, 31 (20.7%) were risk factor analyses, 9 (6.0%) were evaluations, 7 (4.7%) were trend analyses, and 4 (2.7%) were data quality assessments. Knowledge domain mapping identified two major clusters of studies, one on suicide and the other on homicide. The cluster on suicide was commonly linked to "circumstance," "alcohol" and "substance abuse" and the cluster on homicide was commonly linked to "firearm," "injury," and "gang." The two clusters were interlinked to overlapping networks of keywords, such as "firearm" and "mental health problem."

Conclusions: Research utility of the NVDRS has increased considerably in recent years. Studies based on data from the NVDRS are clustered in two knowledge domains – suicide and homicide. The vast potential of the NVDRS for violence research and prevention remains to be fully exploited.

Keywords: Epidemiology, Homicide, Injury, Knowledge domain, National Violent Death Reporting System, Scoping review, Suicide, Violence
creation of a national data system on violent deaths similar to the Fatality Analysis Reporting System developed by the National Highway Traffic Safety Administration (Mercy and Houk 1988; Teret et al. 1992; Barber et al. 2000; Hemenway et al. 2009). After several failed attempts at developing and enhancing violent injury surveillance systems, the CDC halted all activities related to violent injuries in 1996 (Blair et al. 2016; Rovner 1996). However, in 1998, a group of private foundations provided temporary funding to revive the initiative and in 1999, in response to an Institute of Medicine report calling for a national fatal injury system, a pilot program called the National Violent Injury Statistics System (NVISS) was established (Blair et al. 2016).

With growing support for the NVISS, in 2002 the Congress allocated $1.5 million to the CDC to establish the NVDRS (Paulozzi et al. 2004). It became the first multistate system to provide detailed information on the circumstances precipitating violent deaths by culling data from multiple sources (Crosby et al. 2016). In 2003, the surveillance system began data collection in six states: Maryland, Massachusetts, New Jersey, Oregon, South Carolina, and Virginia (Blair et al. 2016; McNally et al. 2016). Since then, the US government has provided an additional $20 million in annual funding to expand the NVDRS to collect data from all states (Barber et al. 2013). As of 2018, the NVDRS has been expanded to all 50 states, the District of Columbia, and Puerto Rico, pooling data from coroner and medical examiner reports, death certificates, law enforcement reports, and toxicology reports using standardized protocols.

Since the launch of the NVDRS, data generated from the system have been used to identify research needs of at-risk populations and develop targeted intervention programs to prevent violent deaths. For instance, the NVDRS data have been used to study homicide and suicide incidents involving older adults and young children, veterans, and law enforcement officers and to document the prevalence of putative risk factors such as alcohol abuse, substance abuse, and financial distress. One study found a significant increase in suicide related to the US housing crisis resulting in foreclosures (Fowler et al. 2015). Another study showed that veterans had a higher risk of suicide in comparison to non-veterans (Hemenway et al. 2009). The NVDRS has helped build alliances among key stakeholders, inform intervention programs, raise awareness, and catalyze new project developments (Horan and Mallonee 2003; Cambell et al. 2006). For instance, the Oregon Violent Death Reporting System staff collaborated with the Oregon Veteran Health Administration to establish prevention programs for veterans (Shen and Millet 2014).

Violent death is defined as a death resulting from either the intentional use of physical force or power against oneself or others (Blair et al. 2016). The NVDRS categorizes violent deaths into the following groups: suicide, homicide, unintentional firearm death, deaths of undetermined intent, deaths due to legal intervention (excluding executions) and deaths due to terrorism (excluding acts of war). Reportable cases are identified based on the codes of the International Classification of Diseases, Tenth Revision, or the manner of death assigned by the coroner, medical examiner or law enforcement (Blair et al. 2016). The NVDRS system is incident-based and records data on both the perpetrator and the victim. In the event of multiple-death homicide, it links all the deaths into one incident record. The NVDRS has been used extensively by researchers. The purpose of this scoping review is to provide a summary assessment of the research utility of the NVDRS through bibliographical analysis, including knowledge domain mapping and network visualization.

Methods
This scoping review was an analysis of bibliographical data for NVDRS-based studies published in peer-reviewed journals. We followed the framework outlined by Arksey and O’Malley (2005).

Eligibility criteria
In the first phase, only the titles and abstracts of potentially relevant studies were screened to match the minimum inclusion criteria. In case of titles for which abstracts were not available, full articles were obtained and reviewed. Publications that were letters, editorials, commentaries, or abstracts only were excluded. Also excluded were articles describing the NVDRS without analyzing the data. Studies eligible for inclusion in this review were those that were based solely or partially on the NVDRS data.

Data sources and search criteria
The search query consisted of “National Violent Death Reporting System” and “NVDRS” and was conducted in six databases: PubMed, EMBASE, Google Scholar, OVID, Scopus, and Web of Science. Search criteria included all the articles published from 2002 to 2018 in English.

Citation management
All citations were imported into the EndNote-PC software. Duplicate articles were manually excluded by sorting and reviewing individual article titles.

Analytical tool
Bibliographical data from studies meeting the inclusion criteria were analyzed with the software VOSviewer (ver. 1.6.10) (Van Eck and Watman 2016) and the online
word cloud generator (Word Clouds, 2019). VOSviewer is a literature knowledge visualization software based on the Visualization of Similarities (VOS) technology. It displays knowledge domain maps and clusters based on network data. VOSviewer is well suited for analyzing large-scale bibliographical data and for constructing complex networks and interactions. Using bibliographic and text data, co-occurrence network, citation network and coupling network can be constructed (Van Eck and Waltman 2010). In this review, we used VOSviewer to map knowledge domains and display the development process and structural relationships of the scientific knowledge covered in the studies. Keywords in the same cluster show the greater similarity with respect to the highest node keyword and positioned within the same cluster. The size of the text within each circle of the

| Database          | Number (n) |
|-------------------|------------|
| Embase            | 164        |
| Google Scholar    | 500        |
| OVID              | 230        |
| PubMed            | 151        |
| Scopus            | 138        |
| Web of Science    | 156        |

**Records identified through database searching (n=1,339)**

**Records after duplicates removed (n=271)**

**Records excluded, with reasons (n=69)**
- Non-related topics (n=57)
- Thesis, books, commentaries, dissertations, opinions (n=12)

**Records screened (n=271)**

**Full-text articles excluded, with reasons (n=52)**
- Retracted articles (n=2)
- Did not use NVDRS directly (n=18)
- Abstracts only (32)

**Full-text articles assessed for eligibility (n=202)**

**Studies included in quantitative synthesis (scoping-review) (n=150)**

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**Fig. 1** Flow diagram of identification, review, and selection of published studies based on data from the National Violent Death Reporting System (NVDRS), 2002–2018
Table 1: Studies based on data from the National Violent Death Reporting System by year of publication, 2002–2018

| Year of Publication | Citation |
|---------------------|----------|
| 2005                | Schecter WP, Klassen C, O'Connor P, Potts M, Ochiltree H. Suicide, the unmet challenge of the trauma system. Archives of Surgery. 2005;140(9):902–4. |
| 2006                | Bennett MD, Jr., Hall J, Frazier L, Jr., Patel N, Barker L, Shaw K. Homicide of children aged 0–4 years, 2003–04: Results from the National Violent Death Reporting System. Injury Prevention. 2006;Suppl 2:i39-43. |
| 2006                | Bossarte RM, Simon TR, Barker L. Characteristics of homicide followed by suicide incidents in multiple states, 2003–04. Injury Prevention. 2006;Suppl 2:i33-8. |
| 2006                | Breiding MJ, Wiersma B. Variability of undetermined manner of death classification in the U.S. Injury Prevention. 2006;Suppl 2:i49-54. |
| 2006                | Campbell R, Weis MA, Millet L, Powell V, Hull-Jilly D, Hackman H. From surveillance to action: early gains from the National Violent Death Reporting System. Injury Prevention. 2006;Suppl 2:i6-i9. |
| 2006                | Hempstead K. Manner of death and circumstances in fatal poisonings: evidence from New Jersey. Injury Prevention. 2006;Suppl 2:i44-8. |
| 2006                | Karch DL, Barker L, Strine TW. Race/ethnicity, substance abuse, and mental illness among suicide victims in 13 U.S. states: 2004 data from the National Violent Death Reporting System. Injury Prevention. 2006;Suppl 2:i22-7. |
| 2006                | Patel N, Webb K, White D, Barker L, Crosby A, DeBerry M. Homicides and suicides - National Violent Death Reporting System, United States, 2003–2004. Mortality and Morbidity Weekly Report. 2006;55(26):721–4. |
| 2006                | Powell V, Barber CW, Hedegaard H, Hempstead K, Hull-Jilly D, Shen X. Using NVDRS data for suicide prevention: promising practices in seven states. Injury Prevention. 2006;Suppl 2:i28-32. |
| 2006                | Sanford C, Marshall SW, Martin SL, Coyne-Beasley T, Waller AE, Cook PJ. Deaths from violence in North Carolina, 2004: how deaths differ in females and males. Injury Prevention. 2006;Suppl 2:i10-6. |
| 2006                | Weis M, Bradberry C, Carter LP, Ferguson J, Kozareva D. An exploration of human services system contacts prior to suicide in South Carolina: an expansion of the South Carolina Violent Death Reporting System. Injury Prevention. 2006;Suppl 2:i17-21. |
| 2007                | Kegler SR. Applying the compound Poisson process model to the reporting of injury-related mortality rates. Epidemiologic Perspectives and Innovations. 2007; 16:41. |
| 2008                | Barber CW, Azael D, Hemenway D, Olson LM, Nie C, Schaechter J. Suicides and suicide attempts following homicide: victim-suspect relationship, weapon type, and presence of antidepressants. Homicide Studies. 2008;12(3):285–97. |
| 2008                | Karch DL, Lubell KM, Friday J, Patel N, Williams DD, Centers for Disease Control and Prevention. Surveillance for violent deaths—National Violent Death Reporting System, 16 states, 2005. Mortality and Morbidity Weekly Report Surveillance Summary. 2008;57(3):1–45. |
| 2008                | Logan J, Hill HA, Black ML, Crosby AE, Karch DL, Barnes JD. Characteristics of perpetrators in homicide-followed-by-suicide incidents: National Violent Death Reporting System—17 U.S. states, 2003–2005. American Journal of Epidemiology. 2008;168(9):1056–64. |
| 2008                | Pamer C, Serpi T, Finkelstein J. Analysis of Maryland poisoning deaths using classification and regression tree (CART) analysis. AMIA annual symposium proceedings. American Medical Informatics Association. 2008: 550–554. |
| 2008                | Shields RT, Ward BW. Comparison of the National Violent Death Reporting System and supplementary homicide report: potential benefits of integration. Justice Research and Policy. 2008;10(2):67–97. |
| 2009                | Fujiwara T, Barber C, Schaechter J, Hemenway D. Characteristics of infant homicides: findings from a U.S. multisite reporting system. Pediatrics. 2009;124(2):e210–7. |
| 2009                | Kaplan MS, McFarland BH, Huguet N. Characteristics of adult male and female firearm suicide decedents: findings from the National Violent Death Reporting System. Injury Prevention. 2009a;15(5):322–7. |
| 2010                | Karch DL, Dahlberg LL, Patel N. Davis TW, Logan JE, Hill HA. Surveillance for violent deaths—National Violent Death Reporting System, 16 states, 2006. Mortality and Morbidity Weekly Report Surveillance Summaries. 2009;58(1):1–44. |
| 2010                | Logan JE, Karch DL, Crosby AE. Reducing “unknown” data in violent death surveillance: a study of death certificates, coroner/medical examiner and police reports from the National Violent Death Reporting System, 2003–2004. Homicide Studies. 2009;13(4):385–97. |
| 2010                | Wanta BT, Schlotthauer AE, Guse CE, Hargarten SW. The burden of suicide in Wisconsin’s older adult population. Wisconsin Medical Journal. 2010;109(2):87–93. |
| 2010                | Genovesi AL, Donaldson AE, Morrison BL, Olson LM. Different perspectives: a comparison of newspaper articles to medical examiner data in the reporting of violent deaths. Accident; Analysis and Prevention. 2010;42(2):445–51. |
| 2011                | Karch DL, Dahlberg LL, Patel N. Surveillance for violent deaths—National Violent Death Reporting System, 16 states, 2007. Morbidity and Mortality Weekly Report Surveillance Summaries. 2010;59(4):1–50. |
| 2011                | Klevens J, Leeb RT. Child maltreatment fatalities in children under 5: Findings from the National Violence Death Reporting System. Child Abuse and Neglect. 2010;34(4):262–6. |
| 2011                | Makkar AS, Martin SL, Halpern CT, Schoenbach VJ. Area disadvantage and intimate partner homicide: an ecological analysis of North Carolina counties, 2004–2006. Violence and Victims. 2010;25(3):363. |
| 2011                | Ortega LA, Karch D. Precipitating circumstances of suicide among women of reproductive age in 16 U.S. states, 2003–2007. Journal of Women’s Health (2002). 2010;19(1):5–7. |
| 2011                | Styka AN, White DS, Zumwalt RE, Lathrop SL. Trends in adult suicides in New Mexico: utilizing data from the New Mexico violent Death Reporting System. Journal of Forensic Sciences. 2011;56(4):1092–9. |
| 2011                | Barber C, Hemenway D. Too many or too few unintentional firearm deaths in official U.S. mortality data? Accident; Analysis and Prevention. 2011;43(3):724–31. |
| 2011                | Betz ME, Valley MA, Lowenstein SR, Hedegaard H, Thomas D, Stallones L. Elevated suicide rates at high altitude: sociodemographic and health issues may be to blame. Suicide & Life-Threatening Behavior. 2011;41(5):562–73. |
| 2011                | Hewes HA, Keenan HT, McDonnell WM, Dudley NC, Herman BE. Judicial outcomes of child abuse homicide. Archives of Pediatrics and Adolescence Medicine. 2011;165(5):466–71. |
Table 1: Studies based on data from the National Violent Death Reporting System by year of publication, 2002–2018 (Continued)

| Year of Publication | Citation |
|---------------------|----------|
| 2013 | Karch D. Sex differences in suicide incident characteristics and circumstances among older adults: surveillance data from the National Violent Death Reporting System—17 U.S. states, 2007–2009. *International Journal of Environmental Research and Public Health*. 2011;8(8):3479–95. |
| 2012 | Bahraini NH, Gutierrez PM, Harwood JE, Huggins JA, Hedegaard H, Chase M. The Colorado Violent Death Reporting System: validity and utility of the veteran status variable. *Public Health Reports*. 2012;127(3):304–9. |
| 2012 | Clark DE, Qian J, Sihler KC, Hallagan LD, Betensky RA. The distribution of survival times after injury. *World Journal of Surgery*. 2012;36(7):1562–70. |
| 2012 | Gold KI, Singh V, Marcus SM, Palladino CL. Mental health, substance use, and intimate partner problems among pregnant and postpartum suicide victims in the National Violent Death Reporting System. *General Hospital Psychiatry*. 2012;34(2):139–45. |
| 2012 | Huq et al. Race, urban context, and Russian roulette: findings from the National Violent Death Reporting System, 2003–2006. *Suicide and Life-Threatening Behavior*. 2011;41(1):33–40. |
| 2013 | Beyer KMM, Layde PM, Hamberger HK, Laud PW. Characteristics of the residential neighborhood environment differentiate intimate partner femicide in urban versus rural settings. *Journal of Rural Health*. 2013;29(3):281–93. |
| 2013 | Caetano R, Kaplan MS, McFarland BH, Conner K, Giesbrecht N. Acute alcohol intoxication and suicide: a gender-stratified analysis of the National Violent Death Reporting System. *Injury Prevention*. 2012;19(1):38–43. |
| 2013 | Karch DL, Logan J, McDaniel D, Parks S, Patel N. Centers for Disease Control and Prevention, Centers for Disease Control. Surveillance for violent deaths—National Violent Death Reporting System, 16 states, 2009. *Morbidity and Mortality Weekly Report Surveillance Summaries*. 2012;61(6):1–24. |
| 2013 | Katz IR, McCarthy JF, Ignacio RV, Kemp J. Suicide among veterans in 16 states, 2005 to 2008: comparisons between utilizers and nonutilizers of Veterans Health Administration (VHA) services based on data from the National Violent Death Index, the National Violent Death Reporting System, and VHA administrative records. *American Journal of Public Health*. 2012;102 Suppl 1:S105-10. |
| 2013 | Lord V. Factors influencing subjects’ observed level of suicide by cop intent. *Criminal Justice and Behavior*. 2012;39(12):1633–46. |
| 2013 | Walsh S, Charnigo R. An ecological approach to preventing suicide using the National Violent Death Reporting System and county level health status data. *Suicidology Online*. 2012;39:217–8. |
| 2014 | Beyer KMM, Layde PM, Hamberger HK, Laud PW. Characteristics of the residential neighborhood environment differentiate intimate partner femicide in urban versus rural settings. *Journal of Rural Health*. 2013;29(3):281–93. |
| 2014 | Caetano R, Kaplan MS, McFarland BH, Conner K, Giesbrecht N. Acute alcohol intoxication and suicide: a gender-stratified analysis of the National Violent Death Reporting System. *Injury Prevention*. 2012;19(1):38–43. |
| 2014 | Karch DL, Logan J, McDaniel D, Parks S, Patel N. Centers for Disease Control and Prevention, Centers for Disease Control. Surveillance for violent deaths—National Violent Death Reporting System, 16 states, 2009. *Morbidity and Mortality Weekly Report Surveillance Summaries*. 2012;61(6):1–24. |
| 2014 | Katz IR, McCarthy JF, Ignacio RV, Kemp J. Suicide among veterans in 16 states, 2005 to 2008: comparisons between utilizers and nonutilizers of Veterans Health Administration (VHA) services based on data from the National Violent Death Index, the National Violent Death Reporting System, and VHA administrative records. *American Journal of Public Health*. 2012;102 Suppl 1:S105-10. |
| 2014 | Lord V. Factors influencing subjects’ observed level of suicide by cop intent. *Criminal Justice and Behavior*. 2012;39(12):1633–46. |
| 2014 | Walsh S, Charnigo R. An ecological approach to preventing suicide using the National Violent Death Reporting System and county level health status data. *Suicidology Online*. 2012;39:217–8. |
| Year of Publication | Citation |
|--------------------|----------|
| 2014               | Nazarov et al. Injury Epidemiology. 2014;1(1):121–9. |
|                   | Conner KR, Huguet N, Caetano R, Giesbrecht N, McFarland BH, Nolte KB. Acute use of alcohol and methods of suicide in a U.S. national sample. American Journal of Public Health. 2014;104(1):171–8. |
|                   | Huber RS, Coon H, Kim N, Renshaw PF, Kondo DG. Altitude is a risk factor for completed suicide in bipolar disorder. Medical Hypotheses. 2014;82(3):377–81. |
|                   | Huguet N, Kaplan MS, McFarland BH. The effects of misclassification biases on veteran suicide rate estimates. American Journal of Public Health. 2014;104(1):151–5. |
|                   | Kaplan MS, Huguet N, McFarland BH, Caetano R, Conner KR, Giesbrecht N. Use of alcohol before suicide in the United States. Annals of Epidemiology. 2014;24(8):588–92.e1–2. |
|                   | Lord VB. Police responses in officer-involved violent deaths: comparison of suicide by cop and non-suicide by cop incidents. Police Quarterly. 2014;17(1):79–100. |
|                   | Niederkrotenthaler T, Logan JE, Karch DL, Crosby A. Characteristics of U.S. suicide decedents in 2005–2010 who had received mental health treatment. Psychiatric Services. 2014;65(3):387–90. |
|                   | Parks SE, Johnson LL, McDaniel DD, Gladden M. Surveillance for violent deaths - National Violent Death Reporting System, 16 states, 2010. Morbidity and Mortality Weekly Report Surveillance Summaries. 2014;63(1):1–33. |
|                   | Searles VB, Valley MA, Hedegaard H, Betz ME. Suicides in urban and rural counties in the United States, 2006–2008. Crisis: The Journal of Crisis Intervention and Suicide Prevention. 2014;35(1):18. |
|                   | Smith SG, Fowler KA, Niolon PH. Intimate partner homicide and corollary victims in 16 states: National Violent Death Reporting System, 2003–2009. American Journal of Preventive Medicine. 2014;104(3):461–6. |
| 2015               | Beyer KM, Layde PM, Hamberger LK, Laud PW. Does neighborhood environment differentiate intimate partner femicides from other femicides? Violence Against Women. 2015;21(1):49–64. |
|                   | Caetano R, Kaplan MS, Huguet N, Conner K, McFarland BH, Giesbrecht N. Precipitating circumstances of suicide and alcohol intoxication among U.S. ethnic groups. Alcoholism, Clinical and Experimental Research. 2015;39(8):1510–7. |
|                   | Cerel J, Moore M, Brown MM, van de Venne J, Brown SL. Who leaves suicide notes? A six-year population-based study. Suicide and Life-Threatening Behavior. 2015;45(3):326–34. |
|                   | Fan MD. Disarming the dangerous: preventing extraordinary and ordinary violence. Indiana Law Journal. 2015;90(1):151–78. |
|                   | Fowler KA, Gladden RM, Vagi KJ, Barnes J, Frazier L. Increase in suicides associated with home eviction and foreclosure during the U.S. housing crisis: findings from 16 National Violent Death Reporting System states, 2005–2010. American Journal of Public Health. 2015;105(2):311–6. |
|                   | Giesbrecht N, Huguet N, Ogden L, Kaplan MS, McFarland BH, Caetano R. Acute alcohol use among suicide decedents in 14 U.S. states: impacts of off-premise and on-premise alcohol outlet density. Addiction. 2015;110(2):300–7. |
|                   | Hemenway D, Solnick SJ. Children and unintentional firearm death. Injury Epidemiology. 2015;2(1). |
|                   | Hempstead KA, Phillips JA. Rising suicide among adults aged 40–64 years: the role of job and financial circumstances. American Journal of Preventive Medicine. 2015;48(5):491–500. |
|                   | Huguet N, Lewis-Laietmark C. Rates of homicide-followed-by-suicide among White, African American, and Hispanic men. Public Health. 2015;129(3):280–2. |
|                   | Huguet N, McFarland BH, Kaplan MS. A comparison of suicides and undetermined deaths by poisoning among women: an analysis of the National Violent Death Reporting System. Archives of suicide research: official journal of the International Academy for Suicide Research. 2015;19(2):190–201. |
|                   | Jiang Y, Perez B, Viner-Brown S. Rhode Island Violent Death Reporting System, 2004–2013. Rhode Island Medical Journal. (2013). 2015;58(8):36–9. |
|                   | Kaplan MS, Huguet N, Caetano R, Giesbrecht N, Kerr W, McFarland B. Economic contraction, alcohol intoxication, and suicide: analysis of the National Violent Death Reporting System. Injury Prevention. 2015;21(1):35–41. |
|                   | Logan JE, Skopp NA, Reger MA, Gladden M, Smolenski DJ, Floyd C. Precipitating circumstances of suicide among active duty U.S. army personnel versus U.S. civilians, 2005–2010. Suicide and Life-Threatening Behavior. 2015;45(1):65–77. |
|                   | Mezuk B, Lohman M, Leslie M, Powell V. Suicide risk in nursing homes and assisted living facilities: 2003–2011. American Journal of Public Health. 2015;105(7):1495–502. |
|                   | Schiff LB, Holland KM, Stone DM, Logan J, Marshall JK, Martell B. Acute and chronic risk preceding suicidal crises among middle-aged men without known mental health and/or substance abuse problems: an exploratory mixed-methods analysis. Crisis. 2015;36(5):304–15. |
|                   | Sheehan CM, Rogers RG, Boardman JD. Postmortem presence of drugs and method of violent suicide. Journal of Drug Issues. 2015;45(3):249–62. |

**Table 1** Studies based on data from the National Violent Death Reporting System by year of publication, 2002–2018 (Continued)
Table 1: Studies based on data from the National Violent Death Reporting System by year of publication, 2002–2018 (Continued)

| Year of Publication | Citation |
|--------------------|----------|
| 2017               |          |
| Choi NG, DiNitto DM, Marti C, Kaplan CN, Conwell Y. Suicide in older decedents aged 50+ years, 2005–2014: trends and associations with sociodemographic and precipitating factors. *The American Journal of Geriatric Psychiatry.* 2017;25(12):1404–14. |
| Choi NG, DiNitto DM, Marti CN. Youth firearm suicide: precipitating risk factors and gun access. *Children and Youth Services Review.* 2017;83:9–16. |
| Choi NG, DiNitto DM, Marti CN, Conwell Y. Physical health problems as a late-life suicide precipitant: examination of coroner/medical examiner and law enforcement reports. *The Gerontologist.* 2017;57(2):356–67. |
| Naimi TS, Xuan ZM, Coleman SM, Lira MC, Hadland SE, Cooper SE. Alcohol policies and alcohol-involved homicide victimization in the United States. *Journal of Studies on Alcohol and Drugs.* 2017;78(5):469–75. |
| Phillips JA, Hempstead K. Differences in U.S. suicide rates by educational attainment, 2000–2014. *American Journal of Preventive Medicine.* 2017;53(4):e123–e30. |
| 2018               |          |
| Annor FB, Bayaky RA, Morrison RA, Bryan MJ, Gilbert LK, Ivey-Stephenson AZ. Suicide among persons with dementia, Georgia, 2013 to 2016. *Journal of Geriatric Psychiatry and Neurology.* 2019;32(1):31–9. [Epub 2018 Nov 26] |
| Annor FB, Zwald ML, Wilkinson A, Friedrichs M, Fondario A, Dunn A. Characteristics of and precipitating circumstances surrounding suicide among persons aged 10–17 years in Utah, 2011–2015. *Morbidity and Mortality Weekly Report.* 2018;67(11):329–32. |
| Choi NG, DiNitto DM, Marti C, Choi BY. Poisoning deaths among late-middle aged and older adults: comparison between suicides and deaths of undetermined intent. *International Psychogeriatrics.* 2018 Oct 24. [Epub ahead of print] |
| Frazier L, Ortega L, Patel N, Barnes J, Crosby AE, Hempstead K. Methods and findings from the National Violent Death Reporting System for identifying gang-like homicides, 2005–2008. *Journal of the National Medical Association.* 2017;109(4):272–8. |
| Perkins ML, Grandner MA, Brown GK, Banner M, Chakravorty S, Morales KH. Nocturnal wakefulness as a previously unrecognized risk factor for suicide. *The Journal of Clinical Psychiatry.* 2016;77(6):e726–33. |
| Sheftall AH, Asti L, Horowitz LM, Felts A, Fontanella CA, Campo JV. Suicide in elementary school-aged children and early adolescents. *Pediatrics.* 2016;138(4). pii: e20160436. |
| Stone DM, Holland KM, Schiff LB, McIntosh WL. Mixed methods analysis of sex differences in life stressors of middle-aged suicides. *American Journal of Preventive Medicine.* 2016;51(Suppl 3):S209–18. |
| Tian N, Cui WJ, Zack M, Kobau R, Fowler KA, Hesdorffer DC. Suicide among people with epilepsy: a population-based analysis of data from the U.S. National Violent Death Reporting System, 17 states, 2003–2011. *Epidemiology & Behavior.* 2016;61:210–7. |
| Fowler KA, Dahlberg LL, Haileyes T, Gutierrez C, Bacon S. Childhood firearm injuries in the United States. *Pediatrics.* 2017;140(1). pii: e20163486. |
| Frazier L, Ortega L, Patel N, Barnes J, Crosby AE, Hempstead K. Methods and findings from the National Violent Death Reporting System for identifying gang-like homicides, 2005–2008. *Journal of the National Medical Association.* 2017;109(4):272–8. |
| Hemenway D, Solnick SJ. The epidemiology of homicide perpetration by children. *Injury Epidemiology.* 2017;4(1):5. |
| Kerr WC, Kaplan MS, Huguet N, Caetano R, Giesbrecht N, McFarland BH. Economic recession, alcohol, and suicide rates: comparative effects of poverty, foreclosure, and job loss. *American Journal of Preventive Medicine.* 2017;52(4):469–75. |
| Kerr WC, Kaplan MS, Liemis RW, Antecedents of suicide among youth aged 11–15: a multistate mixed methods study. *Journal of Youth and Adolescence.* 2017;46(7):1598–610. |
| Reckdenwald A, Simone S. Injury patterns for homicide followed by suicide by the relationship between victims and offenders. *Homicide Studies.* 2017;22(2):111–32. |
| Roberts K, Miller M, Azrael D. Honor-related suicide in the United States: a study of National Violent Death Reporting System data. *Archives of Suicide Research: Official Journal of the International Academy for Suicide Research.* 2017;1(1):31–9. [Epub 2018 Nov 26] |
| Stack S, Bowman B. Cultural Scripts: Analysis of suicide location in film, 1900–2013. *Sociological Focus.* 2017;50(4):346–60. |
| Wong YJ, Wang L, Li SZ, Liu HB. Circumstances preceding the suicide of Asian Pacific Islander Americans and White Americans. *Death Studies.* 2017;41(5):311–7. |
| Year of Publication | Citation |
|--------------------|----------|
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*There were no articles published from 2002 to 2004 and there were 8 articles in 2018 that were published ahead of print*
network visualization map corresponds to the weight/frequency of that keyword within and between the clusters. The software also provides a quantifiable framework through “Total Links Strength” and “Occurrences” analysis. Total links strength is calculated as: \[\frac{\sum \text{Links to other keywords}}{\text{Total links}}.\] The higher the total links strength, the higher the co-occurrence of given keywords. “Occurrences” are the total frequency of a keyword within the data (Van Eck and Waltman, 2016).

**Results**

The comprehensive search returned a total of 1339 potentially relevant articles. Of the 1339 articles, 151 were indexed in PubMed, 164 in Embase, 500 in Google Scholar, 230 in OVID, 138 in Scopus, and 156 in Web of Science. After removing duplicates, 271 articles were included for further review. Of these, 69 did not meet the eligibility criteria due to non-related topics or articles that were thesis, books, commentaries, dissertations, and opinions, leaving 202 articles that were reviewed in full-text. After excluding 52 full-text articles that contained retracted articles, did not use NVDRS or were abstracts only, 150 met the inclusion criteria and were included in the scoping review (Fig. 1 and Table 1). Of the 150 articles, 132 were indexed in PubMed and 147 in Google Scholar.

Of the 150 studies included, 104 (69.3%) studies were on suicide and 39 (26.0%) on homicide. More than three quarters of the studies (82.7%) were published in health and medical journals. Types of studies ranged from descriptive epidemiology (66.7%), risk factor analysis (20.7%), evaluation research (6.0%), trend analysis (4.7%), and data quality assessment (2.7%). Other specific topics assessed included firearms (9.3%), homicide followed by suicide (4.7%) and unintentional firearm-related deaths (2.0%). Of the 150 studies, 27 (18.0%) were based on data from single states.

There were no articles published between 2002 and 2004. The annual number of articles based on data from NVDRS increased from 1 in 2005 to 28 in 2018 (Fig. 2).

Based on size and location of the words in the word cloud, the most frequently used words in the articles were homicide, suicide, NVRDS, and deaths (Fig. 3).
Frequently used words and their interrelations are displayed in the density map (Fig. 4). Suicide was the most researched topic and was commonly linked to “circumstance,” “alcohol” and “substance abuse.” Knowledge domain mapping and network visualization revealed two major clusters and their interconnections (Fig. 5). The larger cluster was on suicide, with total links strength of 7902 and 529 occurrences (Table 2). Alcohol and substance abuse were most frequently examined risk factors associated with suicide. The second cluster was on homicide with total links strength of 3585 and 175 occurrences and was commonly linked to “firearm,” “injury,” and “gang” (Fig. 5 and Table 2).

Discussion
This scoping review provides a general assessment of the research utility of the NVDRS. The results indicate that research output as measured by the number of peer-reviewed publications has increased markedly in recent years. However, the majority of the authors and their publishing outlets are within the field of public health and medicine. The NVDRS is still underutilized by researchers in other disciplines, such as criminology, sociology, economics and policy. NVDRS-based studies are clustered into two knowledge domains; suicide and homicide. Knowledge domain mapping reveals that these studies covered a variety of interrelated topics. Given that suicide comprises the majority of violent deaths in the United States, it is not surprising that suicide is the most frequently researched topic covered in NVDRS-based studies. The term most commonly linked to studies on suicide is “circumstance,” followed by “alcohol,” and “substance abuse.” Homicide is the second most frequently covered topic in NVDRS-based studies. The term most commonly linked to studies on homicide is “firearm”, followed by “injury” and “gang.” Our analysis also shows that studies clustered in the two knowledge domains (i.e., suicide and homicide) are densely interlinked to overlapping networks of keywords, such as “firearm,” “mental health problem,” “substance abuse,” and “men.”

Although knowledge domain mapping sheds light on the development progress and structural relationship among NVDRS-based studies, this scoping review has several limitations. First, our search was limited to six major bibliographical databases for studies published in peer-reviewed journals. NVDRS-based studies published in the “gray” literature, such as theses, dissertations, and conference proceedings, are not included. Second, given the nature of the scoping review that focuses on general exploration of the research topic and its narrative presentation (Peterson et al. 2017), we did not evaluate the quality and findings of the individual studies. Finally, our review was restricted to assessing the research utility of the NVDRS. Use of the NVDRS for policy briefing, advocacy and other functions (Sundararaman et al. 2008) is not included in this review but could be as important as for knowledge creation.
Conclusion

Bibliographical analysis from this scoping review indicates that research output using the NVDRS has increased substantially since 2005. With the expansion of the NVDRS, this upward trend is likely to continue in the coming years. Results from knowledge domain mapping and manual review suggest that although NVDRS-based studies have covered a wide array of topics related to suicide and homicide, they are often focused on a few putative risk factors, such as alcohol and substance abuse for suicide and firearms and gang involvement for homicide. As more data are collected and become available, the vast potential of the NVDRS for violence research and prevention will be explored by investigators from a multitude of scientific disciplines.

Abbreviations

CDC: Centers for Disease Control and Prevention; NVDRS: National Violent Death Reporting System; NVISS: National Violent Injury Statistics System; VOS: Visualization of Similarities

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Availability of data materials

All data generated or analyzed during this study are included in this manuscript.

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Authors’ contributions

ON: literature review; acquisition, analysis, and interpretation of results; drafting of manuscript; critical revision. JG: literature search and review; drafting of manuscript; critical revision. SC: literature review; statistical support; critical revision. GL: study concept and design; oversight and supervision; funding acquisition; interpretation of results; drafting of manuscript; critical revision. All authors read and approved the final manuscript.

Ethics approval and consent to participate

Ethics approval was not needed for this work because it was based on publicly available data and because it did not involve human subjects research.

Consent for publication

Not applicable.

Competing interests

Dr. Guohua Li serves as editor-in-chief of the journal, Injury Epidemiology, and was not involved in the review or handling of this manuscript.

Table 2 Total links strength and frequency of occurrences by major terms within each cluster in knowledge domains covered by studies based on data from the National Violent Death Reporting System, 2002–2018

| Clusters | Terms          | Total links strength | Occurrences |
|----------|----------------|----------------------|-------------|
| 1        | Suicide        | 7902                 | 529         |
|          | Circumstance   | 2470                 | 125         |
|          | Alcohol        | 623                  | 37          |
|          | Substance Abuse| 176                  | 9           |
| 2        | Homicide       | 3586                 | 175         |
|          | Firearm        | 2547                 | 103         |
|          | Injury         | 2236                 | 70          |
|          | Gang           | 450                  | 18          |

Fig. 5 Clusters in the knowledge domains covered by studies based on data from the National Violent Death Reporting System, 2002–2018
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