

Considerations for Developing an Agenda for Gun Violence Prevention Research

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Keywords

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Abstract

In December 2019, for the first time in more than 20 years, the US Congress appropriated, and the president signed, a bill that included \$25 million for gun violence prevention research at the Centers for Disease Control and Prevention and the National Institutes of Health. This research should find ways to reduce injury, death, and suffering while protecting the right of law-abiding citizens to own firearms. Four questions can structure this research agenda. First, what is the problem: How many people get shot, who are they, where does it happen, what is the relationship between the shooter and the victim, what other types of damage are incurred, and are the shootings increasing or decreasing? Second, what are the causes: What is the role of alcohol and drugs; what is the role of gangs, poverty, and systemic racism; what is the role of mental illness, robbery, and domestic violence; what is the role of private gun ownership (both positive and negative) and easy access to guns? What are the factors that protect us, such as stable families and safe environments? Third, what works: Which practices, interventions, policies, and laws work best to prevent these deaths and injuries? And fourth, how do you do it: How do you implement the findings and translate them into policies, legislation, and practices that can be scaled up?

EXECUTIVE SUMMARY

The goal of this research agenda should be to find ways for the United States to reduce injury, death, and suffering while protecting the right of law-abiding citizens to own firearms. This way of approaching what we need to learn will also help us know what we do not know. There is a lot we do know and a lot we do not know, especially with respect to determining which interventions, programs, and policies will both prevent gun injury and protect gun rights. The public health approach to gun violence prevention is based on science, focused on prevention, and collaborative by necessity. Collaboration between public health and public safety is very important. The question we are asking is not whether gun violence is a problem primarily for the public health or criminal justice sector, but how these two sectors can work together—and with other sectors—to maximize public safety and well-being while fully respecting citizen rights. Equity must become another important variable: We must keep focused on the impact of our interventions on racial disparities as we examine the effectiveness of these policies.

The science is organized around four questions, which are used to structure this research agenda. (a) What is the problem: How many people get shot, who are they, where does it happen, what is the relationship between the shooter and the victim, what other types of damage are incurred, and are the shootings increasing or decreasing? (b) What are the causes: What is the role of alcohol and drugs; what is the role of gangs, poverty, and systemic racism; what is the role of mental illness, robbery, and domestic violence; what is the role of private gun ownership (both positive and negative) and easy access to guns? What are the factors that protect us, such as stable families and safe environments? (c) What works: Which practices, interventions, policies, and laws work best to prevent these deaths and injuries? What kind of evidence of effectiveness do we have for policies such as background checks, bans on the sale of high-capacity magazines, child-access prevention laws, concealed-carry laws, firearm sales reporting requirements, gun-free zones, licensing and permitting requirements, lost or stolen firearm reporting requirements, minimum age requirements, prohibitions associated with mental illness, stand-your-ground laws, surrender of firearms by prohibited possessors (including extreme risk protective orders or “red-flag laws”), or waiting periods? What does the evidence show about the effectiveness of voluntary gun safety practices such as using trigger locks, firearm training, self-enrollment in NICS (precommitment against suicide), and the preventive use of firearms for personal protection and to deter crime? (d) How do you do it: How do you implement the findings and translate them into policies, legislation, and practices that can be scaled up? How can researchers better communicate their findings to the public in a way that will change beliefs and culture around guns in a safer and healthier direction, when private gun ownership in the United States is “highly prevalent, culturally entrenched, and constitutionally protected” (55, p. 4)? How can scientific findings be effectively communicated and applied when increasingly large parts of the population are science skeptics and deniers?

In December 2019, for the first time in more than 20 years, the US Congress appropriated, and the president signed, a bill that included \$25 million for gun violence prevention research at the Centers for Disease Control and Prevention (CDC) and the National Institutes of Health (NIH). This article presents a framework and a road map that may be useful for organizing this research. The research agenda should be balanced, objective, and fair. It should be organized in a way that new knowledge can be integrated with what is already known. It should have a clear and easily explained framework so that all interested parties can understand what we know, what we do not know, and what our priority research questions are. Finally, the goal of the agenda is to stimulate

research that will answer the four basic questions and generate answers that can be applied and used as the basis for evidence-based programs, practices, policy, and legislation.

WHERE ARE WE AND HOW DID WE GET HERE?

Science has helped solve many big and messy public health problems, including smallpox and heart disease. And it has helped us find ways to address these problems while preserving personal freedoms. In the United States, in 2018, more than 38,000 gun deaths occurred. Over the past 20 years since the federal funding of gun violence prevention research was stopped, there have been more than 500,000 gun deaths. Nearly 6 out of 10 of these gun deaths were suicides. During those two decades, from 1998 to 2018, the numbers and rate of gun suicides increased from 11,788 (a rate of 4.21/100,000) to 24,432 (a rate of 7.01/100,000), and the number of gun homicides increased from 11,788 (a rate of 4.21/100,000) to 13,958 (a rate of 4.42/100,000) (42). Unintentional gun deaths decreased over the two decades from 866 (a rate of 0.31/100,000) to 458 (a rate of 0.14/100,000), but these account for only 1% of the total gun deaths (42). And for every gun death, an estimated 2–3 nonfatal gun injury cases—sometimes resulting in permanent disabilities—are treated in hospital emergency departments in the United States (42). Guns are used in criminal activity and in defense against criminal activity, and they are responsible for a great deal of social distress. While mass shootings and school shootings account for a small fraction of total gun deaths, these disturbing incidents have occurred more frequently in recent years and consume a large share of media and public attention. Many of these deaths could be prevented by using scientific research to identify evidence-based solutions similar to those that helped save so many lives from motor vehicle crashes, heart disease, cancer, stroke, tobacco, and smallpox. But in this area of gun violence, we are not doing what we could. We are not bringing the full power of science to bear on this problem.

In contrast, most people assume that research is necessary to find better treatments for cancer, heart disease, or stroke and to mitigate or eliminate communicable diseases. They appreciate that biomedical science has contributed to preventing illness and saving lives. To cite just one example, science enabled the eradication of smallpox, a disease that in the twentieth century alone claimed more than 300 million lives.

Most people do not understand what research has to do with gun violence. Why was there not more of a protest about the federal government halting research on gun violence prevention? If the government were to stop research on cancer, or heart disease, or stroke for even one day, there would be a huge outcry. Perhaps most important, those most heavily affected by gun violence have lacked political clout. Those most heavily threatened by gun homicide are young black men, who are murdered at a rate 8–12 times the gun homicide rate for young white men. Similarly, those at highest risk of gun suicide are persons with mental illness, a group that is highly stigmatized. Moreover, many, if not most, citizens do not understand what science can contribute to the prevention of gun violence. They believe it is a problem of criminal justice, not public health; thus, all that is needed is strong enforcement of existing gun laws.

The United States is unique in that compared with other high-income countries, it has the highest rate of gun ownership in the world and very high rates of both gun homicide and gun suicide (19). And while evidence from the United States and other countries has shown that high rates of gun ownership are associated with high levels of gun violence, there is insufficient evidence to prove a causal association (48). The absence of definitive evidence has fostered strong opinions. In a country where many issues are increasingly polarized, the issue of gun violence has become hyperpolarized. How did we get here? Research on gun violence was viewed for many years as a problem for criminal justice. Scientists at the CDC had seen how research initiated by

the federal government to address an epidemic of young people being killed in car crashes led to the introduction of front and side impact protection, seat belts, and air bags. This research led to safer cars, roads, and drivers and saved more than 600,000 lives from 1960 to 2012 (43). With this example clearly in mind, these CDC scientists initiated a research program to find ways to prevent firearm injuries. Their approach was based on science, focused on prevention, and utilized collaboration. One of the most important areas for collaboration was with the criminal justice sector, including law enforcement, the courts, and criminal justice policy.

But just as automobile manufacturers initially fought seat belts and airbags by arguing that “safety doesn’t sell,” firearm manufacturers argued that requirements to reduce firearm deaths by regulating how guns were manufactured, sold, stored, and used—and funding research that could justify such regulations—would hamper gun sales and undermine gun owners’ ability to protect themselves.

THE DICKEY AMENDMENT WAS A WARNING SHOT BUT DID NOT PROHIBIT RESEARCH

Jay Dickey, a congressman from rural Arkansas, threatened the nascent research program at the CDC in 1996 by trying to abolish the CDC’s National Center for Injury Prevention and Control. A compromise inserted in the CDC appropriations bill, called the Dickey Amendment after its sponsor, banned the agency from advocating or promoting gun control and eliminated from the Center’s budget the \$2.6 million it had been spending to support gun violence prevention research. The Dickey Amendment was supposed to be a compromise between those who wanted to stop the research and abolish the injury center and those who thought more research was needed (45). Although it did not specifically prohibit research, the Dickey Amendment had a chilling effect on gun violence research. It removed federal funds from researchers who were already committed to this field and discouraged young researchers from entering the field. Within the CDC, it cast a shadow on those doing gun research.

In a few years, the Dickey Amendment and the elimination of the gun violence prevention research budget essentially brought this research at the CDC to a halt (46). After 1999, the CDC’s funding for gun violence prevention research fell by more than 90% (49). Several years later, in 2003, when the US Task Force on Community Preventive Services (CPSTF; <https://www.thecommunityguide.org/task-force/about-community-preventive-services-task-force>)—a federally financed group of independent experts—conducted a systematic review of published studies on the effects of firearm laws on firearm injuries, it concluded that there was insufficient evidence to say whether any of the many laws considered were effective (20). These laws included bans on specific guns or ammunition, restrictions on gun acquisition, waiting periods, registration and licensing for firearm owners, “shall issue” concealed weapons carry laws, child-access prevention laws, zero tolerance of firearms in schools, and combinations of firearm laws.

While federal funding of gun violence prevention research slowed to a trickle, a small group of foundations—most notably the Joyce Foundation (1, 2) and the California Wellness Foundation—had been funding this research even before the Dickey Amendment, and they continued to fund gun violence research. Much later, they were joined by additional funders who supported research at academic and nonprofit organizations (63). The California state government funded a gun violence research center at the University of California, Davis, where at least one researcher had been funding part of his team’s research from his own private savings. Most recently, the National Collaborative on Gun Violence Research, a private philanthropy started by Arnold Ventures and since joined by other funders, has committed more than \$17 million in funds for research and supports researchers from a broad array of disciplines, including economists, legal scholars,

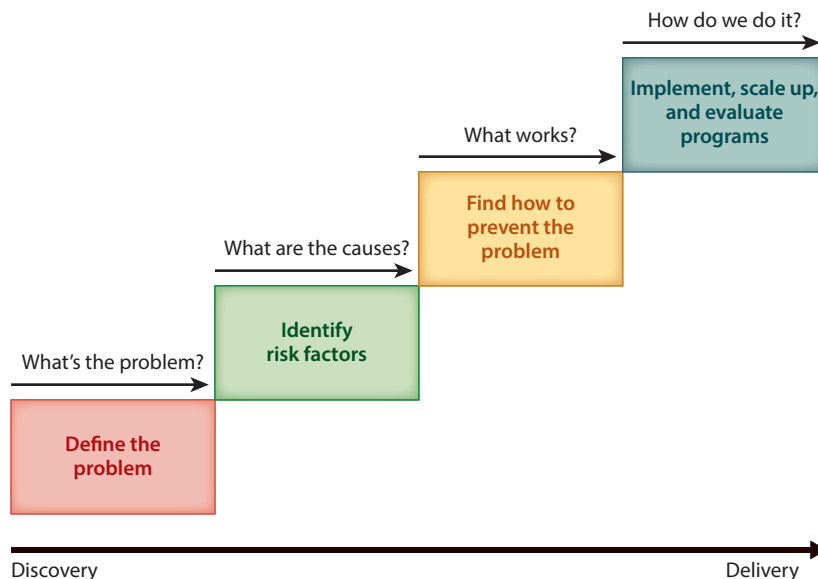


Figure 1

The public health approach is based on the four questions that science asks: What is the problem, what are the causes, what works, and how do you do it?

criminologists, public health, medicine, anthropology, and public policy. These efforts have yielded significant contributions and advanced our understanding in many important ways. The inclusion of a particular topic in this agenda framework should not be interpreted as suggesting that we know nothing about these issues. Rather, topics are included because additional research will expand our understanding and confirm or modify earlier results.

This research agenda is designed to communicate the potential power of science to address gun violence. It uses a framework that clarifies the pertinent questions, shows how new research findings support or change what we already know, and describes how these findings can be applied (**Figure 1**). This framework, developed by CDC injury control research scientists in the 1980s and subsequently adopted widely as the public health approach, addresses four basic questions: (a) What is the problem? (b) What are the causes? (c) What works to prevent these different types of shootings? And (d) how do we translate proven, effective interventions into policy, implement programs, and evaluate the results?

While all four parts of the public health approach are important, the question we as a nation are least prepared to answer is, “What works?” In 2018 and again in 2020 (28), the RAND Corporation (39, 48) analyzed and classified the evidence of the effects of 18 types of gun laws on 8 separate outcomes that are frequently considered when new policies are debated, including homicide and violent crime, suicide, mass shootings, unintentional shootings, police shootings, defensive gun use, hunting and recreation, and effects on the gun industry (37). The results of this review are summarized below as a series of matrices showing the evidence found for the effect of each of the 18 laws on the 8 outcomes (144 possible effects) (**Figure 2**). The investigators rated the strength of the evidence for each effect. Of note, there is not even one single box for which the evidence was considered to be strong. The strongest evidence was what they termed “supportive” and there were only two laws for which the researchers concluded that evidence of any effects was supportive: Child-access prevention laws had supportive evidence that they reduce intentional

POLICIES REGULATING WHO MAY LEGALLY OWN, PURCHASE, OR POSSESS FIREARMS

Gun policies	Gun use outcomes						
	Defensive gun use	Gun industry outcomes	Hunting and recreation	Mass shootings	Officer-involved shootings	Suicide	Unintentional injuries and deaths
Extreme risk protection orders						Inconclusive	
Minimum age requirements				Inconclusive		Limited	Inconclusive
Prohibitions associated with domestic violence						Inconclusive	Moderate
Prohibitions associated with mental illness						Inconclusive	Limited
Surrender of firearms by prohibited possessors							Inconclusive

POLICIES REGULATING FIREARM SALES AND TRANSFERS

Gun policies	Gun use outcomes						
	Defensive gun use	Gun industry outcomes	Hunting and recreation	Mass shootings	Officer-involved shootings	Suicide	Unintentional injuries and deaths
Background checks		Inconclusive		Inconclusive		Inconclusive	Moderate
Bans on low-quality handguns		Inconclusive				Inconclusive	Inconclusive
Bans on sale of assault weapons and high-capacity magazines		Limited		Inconclusive			Inconclusive
Firearm safety training requirements		Inconclusive					Inconclusive
Firearm sales reporting, recording, and registration requirements		Inconclusive		Inconclusive			
Licensing and permitting requirements		Inconclusive		Inconclusive		Limited	Inconclusive
Lost or stolen firearm reporting requirements							
Waiting periods		Inconclusive		Inconclusive		Moderate	Moderate

POLICIES REGULATING THE LEGAL USE, STORAGE, OR CARRYING OF FIREARMS

Gun policies	Gun use outcomes						
	Defensive gun use	Gun industry outcomes	Hunting and recreation	Mass shootings	Officer-involved shootings	Suicide	Unintentional injuries and deaths
Child-access prevention laws		Inconclusive		Inconclusive		Supportive	Supportive
Concealed-carry laws		Inconclusive		Inconclusive		Inconclusive	Limited
Gun-free zones							
Laws allowing armed staff in K–12 schools							
Stand-your-ground laws	Inconclusive	Inconclusive		Inconclusive		Inconclusive	Supportive

Figure 2

When investigators rated the strength of evidence found for the effect of each of the 18 laws on the 8 outcomes (144 possible effects), they concluded that there is not even one single effect for which the evidence was considered to be “strong.” The strongest evidence they found was felt to be “supportive.” Figure adapted with permission of the RAND Corporation.

and unintentional firearm self-injuries among children, and supportive evidence suggested that stand-your-ground laws increase firearm homicides (28).

I have reviewed a number of existing research questions and priority statements (consensus statements based on a mix of evidence and opinion) (3, 7, 18, 24, 26, 28, 31–34, 39, 40, 52, 53, 56, 58, 59, 62, 65–69, 71, 72, 74) and, in particular, looked at the research agenda that was developed by the Institute of Medicine for the CDC in 2011 (32). The framework offered here is meant to be easier to understand and communicate by comparison. We also reviewed existing gun research systematic reviews and sought input from advocacy and academic stakeholders. The framework and questions below are meant to be more of a road map for how this research might proceed rather than a compilation of all the research that has been done to date or what we know about gun violence prevention. Listing a specific area or question on this agenda does not mean that there is no research to address this question. Rather, it indicates an area where our policies and programs and our communities could benefit by knowing more. Science is not static; rather, our knowledge is constantly evolving.

WHERE DO WE NEED TO GO? WHAT ARE THE MAJOR CATEGORIES OF QUESTIONS THAT RESEARCH NEEDS TO ANSWER?

We propose that the framework of the agenda consists of four separate questions, the basic steps of the public health approach. Each of these four organizing questions is listed and explained below, followed by more specific questions that should guide further research.

What Is the Problem?

This first step in the public health approach includes the questions that any good reporter would ask: who, what, where, when, and how. These questions include the basic descriptive epidemiology of gun violence to answer the questions of who gets shot, where, when, and how? Are there subgroups for whom firearm injuries are increasing, decreasing, or holding steady? For interpersonal violence, what is the relationship between the shooter and the victim? Although many studies have examined individual characteristics associated with firearm violence and suicide, much less is known about family, community, and ecological factors that may be associated with victimization or the commission of gun violence. What kind of weapons are involved and how were they acquired? How should this information best be collected, analyzed, and disseminated? Some more specific research questions are discussed as follows.

How can we collect, analyze, and utilize better data and information to reduce injury risk and to reduce disparities?

Timely information is essential to inform public health and criminal justice action. The use of accurate, real-time data to inform decision-making is as essential for injury control as it is for the control of infectious diseases. But, unlike for many infectious diseases, the United States does not have standard, national data on firearm injuries and efforts to prevent them. The CDC has developed the National Violent Death Reporting System (NVDRS), which at least for fatal firearm injuries functions as a national reporting system, now expanded to all 50 states (41). NVDRS “links information about the ‘who, when, where, and how’ from data on violent deaths and provides some insights about ‘why’ they occurred.” NVDRS pools more than 600 unique data elements from multiple sources into a usable, anonymous database. NVDRS covers all types of violent deaths—including homicides and suicides—with different means, in all settings for all age groups (41).

How can we develop standards for state-, county-, and city-level public reporting to improve NVDRS and other data systems with special attention to more accurate and timely counts

of nonfatal as well as fatal injuries? Official government data are a trusted, reliable source of information for the media, academic organizations, and citizens. Efforts have been initiated by state, county, and city public health and law enforcement departments to share such data. How can we establish standard data elements and indicators for publicly reporting essential data using consistent indicators that can be compared both across regions and over time? How can we strengthen our relevant data systems needed to adequately describe and better understand the problem, with attention to data quality, accessibility, and aggregation, data to assess gun acquisition and storage, data fragmentation and standardization, and new research methods (40, 44)? How are guns typically stored in homes? What is it that makes a family more likely to store guns safely when there are children in the home? Better and more timely data on risks associated with different storage practices for specific household configurations would allow individuals and communities to both understand and reduce their firearm injury risk, start to measure the impact of different control measures on law-abiding gun owners, foster transparency about the effectiveness of control measures, and drive continuous improvement (35). If our government can provide us with the number of chickens that were slaughtered in the last month (<https://www.nass.usda.gov/>), we should not have to wait more than a year to find out how many people were killed, shot, or assaulted during that same period.

How can we most effectively collect and use data and information to best measure disparities in the impact of gun violence on individuals, families, and communities? How do we collect the information we need to make racial and/or ethnic disparities a key outcome variable in our research into these laws' effectiveness (54)? What do we know about the disproportionate impact of gun violence on minority communities and its effects on social capital, income, education, mental health, and property values?

What are the benefits associated with gun possession for gun owners, their families, and their communities? How do these trade-offs between gun costs and benefits differ across subgroups in the United States? How do we measure the benefits of gun ownership for their owners, their families, and their communities in terms of safety, security, and sense of well-being from recreational use; from hunting; and from defense of self, family, and community?

How often are guns used to deter or prevent a crime? How often, and in what circumstances, are children and adolescents actively protected by their own self-defensive firearm use or that of someone else (e.g., friend, parent, or acquaintance) (10–12)? When guns are used to deter a crime, in what percent of cases is there a physical injury or death? Research is needed to better define what precisely is being measured, whether existing studies and reports are accurate, and what kinds of studies are needed to provide reliable answers with respect to the frequency and effectiveness of defensive gun use.

What are the costs of gun violence in terms of not only the number of victims injured or killed, but also the impact of these shootings on family and community? How can we measure the impact of the threat of gun violence, how it impacts communities and traumatizes individuals, and how it stresses schoolchildren and their parents? How can we measure the social burden of gun violence? What are the economic, social, and psychological costs of gun violence over and above the costs of deaths and physical injuries themselves? How do we measure the costs associated with the “anticipation of victimization that engenders widespread anxiety, disinvestment in impacted communities, and costly efforts to avoid and mitigate attacks?” (P.J. Cook, unpublished communication; 11). What are the advantages and disadvantages of different measurement approaches, such as the cost of illness approach and the contingent valuation method (12)? What are the economic costs of firearm violence (7)?

How can we better understand how guns are distributed, carried, and used in the United States? What are the economics of gun supply and demand? How do the legal gun markets work and how are illegal gun markets (thefts, straw purchases, trafficking, ghost guns, etc.) structured? How do guns move from rural owners to urban gangs? How many new guns are sold in each state each year, and how have gun sales been trending? How many used guns change hands each year? How long, on average, do guns of different types remain usable and in circulation? What trends are there in the issuance of concealed-carry permits, who seeks concealed-carry permits, and how often do permit holders choose to carry their weapons in public? How can the supply of guns that are used in crimes be cut off without interfering with the supply of guns to law-abiding gun owners? The legal ownership of firearms comes at a social and economic cost: In large part, the supply of guns to offenders involves the diversion of guns from legal commerce and ownership (9, 11, 13). What are the beliefs and motivations of those who do and do not want guns (risk perceptions, cultural norms, uses)? How much means substitution occurs when firearm deaths are prevented? What are the conditions under which means substitution does and does not occur?

How can we improve information collected by police about gun violence? In order to prevent future crimes, how can we improve police investigations of criminal shooting incidents, including assaults and homicides, by using deterrence, incapacitation, and possibly interruption of private revenge cycles (12)? How many officer-involved shootings occur each year, and where? How many of these are determined to be lawful? What features of officers, their departments, or the communities they serve are associated with the risk of such shootings?

Can we learn more about where guns are carried and used? Increased attention is needed to determine where people can carry guns, who can carry them, how they carry them (i.e., openly or concealed), and what kind of weapons they can use. This approach looks at policy approaches to three simultaneous areas, where each area can be portrayed as one of three overlapping circles in a Venn diagram. One circle is “place,” another is “guns,” and a third is “people.” In the very center where all three circles overlap is the area defining where people with certain characteristics possess guns and can carry them in a well-defined place. Gun violence prevention policies can define the people who are allowed to have guns and carry them in a given place. By varying the degree of restrictions on these three policy realms, one can set a policy and empirically see their effect on gun violence as well as the impact on the rights of law-abiding gun owners (S. Teret, personal communication).

What Are the Causes?

For many risk factors, it is possible to state that there is an association between a particular factor and gun violence, but it usually requires much better data and studies to prove a causal relationship between a particular factor and the gun violence outcome. Demonstrating causality usually requires experimental trials or observational cohort or case-control study designs that use comparison groups (6). Better data are also needed to establish how much of an individual's risk for involvement in gun violence is actually attributable to social, economic, and environmental factors. Sometimes this step is referred to as risk factor identification. But a risk factor requires establishing only whether an association exists; more research is needed to establish causality. How can we identify those factors that protect individuals and communities from the risk of gun violence? Are there circumstances in which gun possession is protective?

Individual risk factors for firearm homicide perpetration and victimization. Research is needed to further understand the relationship of these risk factors to firearm homicides, to further

clarify those situations in which these risk factors play a causal role, and to explain how these risk factors interact when present at the same time (30). This information may allow researchers to develop profiles of very high-risk individuals and situations. These risk factors include alcohol and drugs; mental illness, especially depression, bipolar disease, and schizophrenia; economic motivations such as robbery; gangs; easy access to weapons and the influence of particular weapon types on crime; intimate partner violence; and workplace violence (61). Research is also needed to clarify the risks associated with exposure to firearm violence and other forms of violence, especially for children. How does childhood exposure to gun violence affect the development of children? To what extent does the availability of guns influence the choice of weapon in criminal violence? To what extent do legal consequences for gun crime affect offenders' choices (12, 13)?

Individual risk factors for firearm suicide. What are the risk factors for firearm suicides (16, 25, 27, 29, 36, 50, 51, 55, 57, 59, 60, 67)? To what extent does access to firearms affect the risk for suicide? What are the causes and risk factors for gun suicide in veterans? What is the impact of exposure to suicide within a family, a group of acquaintances, or a community?

Risk factors for perpetration of mass shootings. What are the causes behind the recent increases in mass shootings? Perpetrators of mass shootings are often suicidal: Is there a cluster of risk factors for both gun suicide and homicide that can help to identify persons at high risk for perpetrating a mass shooting? What is the role of domestic violence in mass shootings? Can a focus on school or workplace grievances identify an individual as high risk for perpetrating mass shootings? What is the role of social alienation, discrimination, hopelessness, and unemployment?

Causes of disparities in firearm violence among different race, ethnic, and gender groups. What explains the marked disparity in firearm homicides between men of color and white men? What are the social and economic determinants and antecedents of gun violence? What impact does structural racism have on gun violence? Is there a belief that the failure of law enforcement to arrest and capture perpetrators of gang violence reflects a lack of police officials' interest in minority communities and, in particular, the lives of minority males (11, 12)?

What are the characteristics and what are the physical and social features of locations at high and low risk for gun violence? How do stress and trauma in a community affect firearm-related violence? What are the social and economic factors that increase an individual's risk of involvement in gun violence? What are the community consequences of exposure to firearm violence, and how might exposure be uncoupled from those consequences (G. Wintemute, personal communication)? How do structural racism and economic disadvantage affect firearm-related violence (32)?

Risk factors in police shootings. What is the role of unconscious bias in police shootings? What policies are effective in preventing police shootings that may be deemed unnecessary? Because many mass shooters commit suicide or plan to have themselves shot by a police officer, how often is suicide a primary motivation for mass shooters?

What Works to Prevent Gun Violence and Protect Gun Rights?

To answer the question of what works, one must find interventions that simultaneously satisfy two objectives: reducing gun violence and protecting the rights of law-abiding gun owners. These are not mutually exclusive objectives. Through gun violence prevention research, we can find interventions that will achieve both objectives: protect gun rights and reduce gun violence. Strategies

that work by meeting both objectives might, for example, aim to keep guns out of the hands of those who should not have them while allowing law-abiding gun owners to keep their guns. These strategies should be carefully crafted using behavioral risk factors and targeted to individuals at high risk for gun homicides or gun suicides while fully respecting constitutional law and policies (55). Once we find these strategies, research will be needed to prove that these interventions work to both reduce gun violence and protect gun rights. A third objective of this research should also be to find interventions that will reduce racial disparities in terms of the burdens of gun violence and in the ways that laws are applied. Some of the answers to these questions will come from the analysis of existing data sets, others may require new data collection efforts, and some may require large-scale controlled trials that cover multiple jurisdictions over a sustained period of time. Federal and state governments may have a unique role to play in helping to design and implement such studies, especially when they will require the collaboration of different departments (such as police, public health, housing and urban development, education, health care, and mental health). Examples of possible ways to achieve both objectives include universal background checks, eliminating loopholes, and tracking results; access restrictions for domestic violence offenders; red flag laws; and safe storage (50).

How do we measure the extent to which an intervention or policy impacts the rights of law-abiding gun owners? Research is required to develop a way to measure the impact of different interventions on the rights of law-abiding gun owners. Just as environmental impact measures help us protect the environment, this research will help us protect and measure gun rights. What gets measured gets done.

What are the benefits and costs of gun ownership? What are the benefits and costs of gun policies for law-abiding gun owners, individuals who do not own guns, and other stakeholders (e.g., police, school personnel)? Does having more law-abiding citizens carry weapons deter crime and reduce gun violence? Are firearm safety programs that include improved safety practices for firearm owners effective?

How effective are interventions that focus on firearm regulations and regulatory enforcement? How can the evidence needed to make scientifically sound statements about the effectiveness of a broad range of interventions focused on firearm regulations and regulatory enforcement be collected to assess background checks, bans on the sale of high-capacity magazines, child-access prevention laws, concealed-carry laws, firearm sales reporting requirements, gun-free zones, licensing and permitting requirements, lost or stolen firearm reporting requirements, minimum age requirements, prohibitions associated with mental illness, stand-your-ground laws, surrender of firearms by prohibited possessors [including extreme risk protective orders (5, 14–18, 21, 47, 64, 73) or red-flag laws], and waiting periods?

How effective are each of these interventions listed above for the different categories of gun use, including defensive gun use, hunting and recreation, mass shootings, officer-involved shootings, suicide, unintentional injuries and deaths, violent crime, terrorism, and hate crimes? What would be the effect of extending background checks to include currently undocumented sales and transfers (23, 38, 70)?

What are the strategies for keeping guns from individuals who should not legally have them? How can the effectiveness of regulations for gun transactions be improved? What enforcement policies are effective in preventing the diversion of guns from legitimate private hands into criminal hands (9, 13)? How can we effectively write and enforce these laws so that they keep guns away from people who should not legally purchase or possess them while not infringing on the rights

of law-abiding gun owners? How can we improve police investigations of criminal shooting incidents, including assaults and homicides? Solving past crimes prevents future crimes: deterrence, incapacitation, and possible interruption of private revenge cycles (12).

What are the effects of alternative law enforcement strategies? How can enforcement of existing laws be improved? What are the most cost-effective strategies for holding perpetrators of shootings accountable by investigating to increase arrest and conviction rates (8, 9, 13)? How can we best assess the costs and benefits of policies designed to reverse the long-term decline in arrest and conviction rates (9)? To what degree is state and local law enforcement oversight of gun dealers, including licensing, inspections, and stings, effective at reducing illegal gun trafficking?

Assessing the impact on gun deaths of suicide and interpersonal violence prevention programs that are not specifically focused on firearms. What are the most effective interpersonal violence prevention programs, and how can we continue to improve their effectiveness (including programs that are not focused specifically on guns, such as mentoring and early child development programs, job training programs, housing, and antipoverty programs that address socioeconomic determinants)? How can we prevent gun suicides by suicide prevention programs that are not focused specifically on firearm accessibility?

Engineering and technological innovations to reduce gun violence. Which technological innovations are effective and what new innovations can be developed? Innovations would include “safe guns” as well as new technologies that might be developed. Can smaller-caliber weapons be substituted for larger-caliber weapons to reduce their lethality and save lives without substantially limiting the benefits of firearm ownership?

Educational and communication programs. If some gun owners have incorrect beliefs about the average risk of, for instance, gun ownership or safe storage practices, what communication strategies would be most successful in bringing their beliefs in better alignment with the available evidence?

Measuring the effectiveness of interventions to reduce health and economic disparities. How effective are behavioral interventions to reduce crime and school dropout among economically disadvantaged youth (22)? There is some evidence that providing mentoring, training, and job opportunities for young people facing poverty and discrimination can reduce their involvement in gun violence. Can these programs be delivered consistently and over the course of several years? Can they be scaled up and rigorously evaluated?

Individual and population-based interventions through the health care sector. What impact can health care providers and organizations have by improving the care we provide in all domains—physical, psychological, and spiritual—for those who are victims of violence? Because gun violence is often closely linked to other forms of violence—including sexual assault, intimate partner violence, child abuse, and elder abuse—how can the full power of both health care institutions and criminal justice institutions be mobilized to address all forms of violence? How can organizations and institutions, including the military, mobilize people and policies to recognize people at risk of victimization or perpetration and help them using interventions focused on prevention as well as enforcement? What can nongovernmental groups (e.g., universities, labor unions, standards writing organizations, insurance companies, gun trainers, hospital accreditors, therapists, the faith community, the media, the Red Cross) do that can effectively reduce firearm violence (4)?

How Do We Translate Proven Effective Interventions into Policy and Legislation? How Do We Scale Up Programs and Implement Them?

Once interventions or programs are shown to work—i.e., by limiting illegal use without infringing on the rights to legal use, while preserving the positive aspects of gun possession and use—in a well-controlled setting (i.e., efficacy has been demonstrated), how do they get scaled up to cover a larger target audience and a wider geographic area? How do we take the information derived from a program that has proven effective and use that evidence to develop policies and legislation? How can we take the relevant evidence from research and deliver it to law makers and politicians at every level so that they can use it effectively to make evidence-based policy? How do we develop and monitor the capacity to implement, practice, and enforce that policy?

How can we improve the data and information needed to evaluate program and policy implementation? We need to improve our data collection and dissemination methods. Even if programs that are proven effective are used to generate policies, it will be important to collect and analyze the data that can show whether and how well the policies are working. We will need to keep collecting data to keep improving our programs and refining our policies. The NVDRS is one very important data set that should be supported and improved because its data can be used to examine the impact of evidence-based policies (41).

Continue to build the nation's research capacity. We in the United States will have to invest in strengthening our research capacity by training researchers from an array of disciplines and expanding their data collection and analysis capabilities.

How can we better measure the effectiveness of education and information campaigns?

How can the scientific evidence about firearms and public health be conveyed most effectively to gun owners, law makers, and others to promote behaviors that reduce firearm violence? Who are the trusted messengers who can reach gun owners to let them know that gun safety and gun rights are not in conflict? What do we know about how gun owners are organized, formally and informally, to help accelerate the practices proven to reduce suicide, domestic violence shootings, and unintentional injuries?

WHICH VALUES AND QUALITIES DOES THE RESEARCH PROGRAM NEED TO EXHIBIT?

It would be useful to survey a broad range of researchers, institutions, and interested parties to see what they would like this research agenda to cover. The answers to the research questions need to be understood as they apply to a diverse set of vulnerable groups (e.g., Blacks, Hispanics, Native Americans, people with mental illness, Veterans, and LGBTQ individuals). This research cannot assume that findings will hold across racial/ethnic groups or other relevant categories of people at high risk. A variety of different types of grants and organizations should be utilized, including individual researcher-initiated grants (these should be made available to examine the effectiveness of interventions, programs, and policy and may contribute to more than one of the four primary question areas); gun violence research centers; and large multiyear, multicentered grants to assess the effectiveness of different policies and programs. Research program administrators should understand how we got to this impasse in research funding to understand that in moving forward it will be important to have research oversight by scientists to ascertain whether the research is both leading to improvements in gun violence prevention and protecting the rights of law-abiding gun

owners. The review process should also be explained to the public. The panels of scientists who review the grant applications and vote for the awards must avoid bias and conflicts of interest and pursue objectivity in their decisions. In an area that is so politically charged, it will be critical to assure that this research is characterized by scientific objectivity and credibility. Once grants are awarded, grants should be monitored to assure that the research will be of high quality.

Equity must become an important value as effectiveness is evaluated. It will be very important to work closely with affected communities to make progress jointly in the search for solutions (54, 55, 61). How can we vigorously enforce effective gun laws while stopping the over policing and mass incarceration of young men of color (54)? These are hard questions, but addressing them is both important and urgent.

The research agenda that is developed might serve as a guide for the CDC and the NIH as they invest new congressional funds in research to prevent gun violence. The research program that will serve the American people best is one that draws on multiple disciplines and involves multiple governmental departments. The CDC and the NIH can collaborate and develop complementary approaches. The disciplines that should be involved include epidemiology, law, sociology, psychology, anthropology, statistics, political science, decision theory and quantitative analytical methods, medicine and medical specialties, education, urban development, economics, and economic development. This research agenda should not only provide guidance for organizations that fund gun violence prevention research, but also help others push for the enforcement of evidence-based legislation and policies and strengthen the data collection and enforcement powers of local agencies and federal agencies such as the CDC, the NIH, the National Institute of Justice, and the Bureau of Alcohol, Tobacco, Firearms and Explosives. The US governmental departments that should be involved include the Department of Health and Human Services, the Department of Justice, the Department of Housing and Urban Development, the Department of the Treasury, the Department of Homeland Security, the Department of Energy, the State Department, the Department of the Interior, and the Department of Commerce.

This agenda is not intended only for public health. The criminal justice sector plays a role that is every bit as important, and research questions should help to fully utilize the experience and resources of that sector. Many people believe that gun violence is a problem of public safety and not of public health. They believe that law enforcement should be concerned with gun violence and should use the techniques of investigation, incarceration/incapacitation, and deterrence to reduce gun violence. They also believe that because the safety of the public—and not just their health—is threatened by gun violence, public safety officials should be the group involved in and in charge of these efforts. But the critical question is not in which department or discipline does this research belong; rather, how can they collaborate and work effectively together? Criminal justice and the legal system have very important roles to play in reducing gun violence, and this agenda should be designed to help guide their research and evidence development as much as it may help guide public health. In fact, to advance some of the research—such as large-scale, long-term, multijurisdictional studies of the effectiveness of different gun laws—close collaboration between public health and public safety agencies will be necessary. Saying that firearm violence is a public health problem is not saying that public health is the most important or only important sector to address this problem. Public health does not own the problem of gun violence. Public health needs to pay attention to this problem because it is such a significant cause of death, disability, injury (both physical and psychological), and distress. Public health needs to pay attention to gun violence because it has tools and approaches that can contribute to reducing the burden. We are also saying that public health must collaborate closely with criminal justice and public safety. The government funding agencies should do more than support some research in criminal justice and some in public

health. It would be much more productive to encourage real collaboration, with both disciplines working on the same problem together. And these efforts should go beyond public health and criminal justice to include close collaboration with education, housing and urban development, labor, treasury, homeland security, and the state department.

Research programs should avoid getting caught in a partisan battle because there will be a need to grow these programs and increase the funding for this research. There is no single magic remedy that, once discovered and proven effective, will solve the larger problem of gun violence in one fell swoop. Instead, the progress will be incremental, much like there is no single solution to the problem of motor vehicle injuries and deaths; rather, 50 years of federally funded research have produced front-, side-, and rear-collision impact protection; seatbelts and child safety seats; many types of air bags; safer roadway design; and safer drivers. These changes have been incremental and additive. Progress in gun violence prevention will take a similar path. We need bipartisan action to advance the science of gun violence prevention, and this needs to be a long-term project with long-term funding. In 2019, for the first time in more than 20 years, the US Congress appropriated, and the president signed, a bill that included \$25 million for gun violence prevention research at the CDC and the NIH. This amount is just a beginning.

THE FOUR PHASES OF KNOWLEDGE DEVELOPMENT: GENERATION, INTEGRATION, DISSEMINATION, APPLICATION: HOW DO WE DO THIS?

In listing the specific areas that should be explored, this article has focused on the questions that gun violence prevention research should work to answer. This research will generate information and evidence. But once generated, this new information needs to be integrated with what is already known. Getting the research funded and finished will not in itself stop the problem. Next, the information needs to be disseminated. And finally, it needs to be used or applied by those who make policy, design programs, and pass legislation. Each of these steps takes time, but there are ways to accelerate the process. Developing and training the human resources needed to do each of these steps could be started now. Our ability to answer all four of the big research questions is dependent on better and more complete data to address almost all the questions in this agenda, and, of course, we need a new generation of researchers. Three related needs across the board are funding, data, and researchers. Twenty-five million dollars is a start—or we should say a restart—but is not enough to proceed at the rate that this problem demands: The existing data are inadequate, and we need young researchers to enter this field. The enormous burden of gun violence will not be clearly seen until we start to add the social costs of disrupted and stressed lives and communities to the lives lost, physical and psychological injuries sustained, and lives left to be lived with serious disabilities (P. Cook, unpublished). Indeed, as Cook & Ludwig wrote, “Whether the social costs of gun ownership are positive or negative is arguably the most fundamental question for the regulation of firearms in the United States” (11, p. 380). The extremely inequitable way in which the burdens of gun violence are borne should also propel us to seek solutions much sooner than later. These are burdens that we all bear and burdens from which science can free us.

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