Effectiveness of Interventions to Promote Safe Firearm Storage

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Despite supportive evidence for an association between safe firearm storage and lower risk of firearm injury, the effectiveness of interventions that promote such practices remains unclear. Guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist, we conducted a systematic review of randomized and quasi-experimental controlled studies of safe firearm storage interventions using a prespecified search of 9 electronic databases with no restrictions on language, year, or location from inception through May 27, 2015. Study selection and data extraction were independently performed by 2 investigators. The Cochrane Collaboration's domain-specific tool for assessing risk of bias was used to evaluate the quality of included studies. Seven clinic- and community-based studies published in 2000–2012 using counseling with or without safety device provision met the inclusion criteria. All 3 studies that provided a safety device significantly improved firearm storage practices, while 3 of 4 studies that provided no safety device failed to show an effect. Heterogeneity of studies precluded conducting a meta-analysis. We discuss methodological considerations, gaps in the literature, and recommendations for conducting future studies. Although additional studies are needed, the totality of evidence suggests that counseling augmented by device provision can effectively encourage individuals to store their firearms safely.

firearms; program evaluation; safety

Abbreviations: DVRO, domestic violence restraining order; IPH, intimate partner homicide; IPV, intimate partner violence.

INTRODUCTION

According to the Centers for Disease Control and Prevention, about 118,000 Americans including 18,000 individuals younger than 20 years of age sustained fatal or nonfatal firearm injuries in 2013 (1). Such injuries lead to substantial mortality, psychological and physical morbidity, and high costs resulting from medical expenses, reduced productivity, and diminished quality of life (2–7). Gun ownership is an independent risk factor for firearm injury (8–16), and estimates indicate that guns are present in about one third of US households (17, 18). However, only a few interventions aimed at limiting firearm ownership have been tested (19–21), and such prevention strategies remain socially and politically contentious. Some studies have also suggested that gun owners prefer not to be asked to remove firearms from their homes (22, 23).

Notably, more than one half of US households store a gun unlocked and/or loaded (17, 24), which provides an opportunity to pursue other strategies to prevent firearm injuries. Safe storage, including methods such as keeping guns unloaded, locked, and separate from locked ammunition, has been widely

endorsed as a firearm injury prevention strategy by medical professional societies (25–27). Several firearm advocacy organizations have also encouraged some form of safety practices as an integral element of responsible gun ownership (28–30). Importantly, adult patients and parents of pediatric patients do not seem to be bothered by conversations about guns (22, 23, 31), and the concept of safe firearm storage has enjoyed broad public support (32).

Case-control and cross-sectional studies among children and adults have consistently shown a lower risk of self-inflicted firearm injuries and deaths in households that practice safe storage compared with those in which guns are stored unlocked and/or loaded (9–11, 13, 15, 33, 34), although some of those studies were limited by insufficient statistical power (9, 10, 34). In addition, a study of a nationally representative sample of suicide decedents found that individuals living in households with safe storage practices were less likely to commit suicide using a firearm (35). This finding is notable because of the importance of specifically preventing *firearm-related* suicide attempts since the case fatality of those (85%) is greater than that of other methods such as suffocation (69%)

or poisoning (2%) (36). Given that suicide attempts are commonly impulsive acts (37, 38), safe firearm storage may mitigate the risk of fatal self-harm by reducing immediate access to lethal means. Our knowledge on the association between safe firearm storage practices and risk of unintentional or assault-related firearm injuries is somewhat limited. Nonetheless, a few studies have indeed observed a lower risk of unintentional and assault-related firearm injuries among individuals living in households that practice safe firearm storage (13, 14, 39).

Several community- or clinic-based interventions have been conducted to promote safe firearm storage practices. A systematic review of such interventions that included 1 randomized controlled trial and 6 before-after or after-only studies was published in 2003 and found that 4 of 7 studies demonstrated effectiveness in improving household firearm storage practices (40). Considering methodological limitations of included studies, the authors concluded that it was not clear what types of interventions or which specific components of those may encourage gun owners to securely store their firearms (40). We sought to systematically review all randomized

and quasi-experimental controlled studies that tested the effectiveness of community- or clinic-based safe firearm storage interventions.

METHODS

Data sources and search strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (41) were followed in the conduct and reporting of this systematic review. A broad search strategy was used to encompass the full range of safe firearm interventions. Published studies were identified and cross-checked by 2 reviewers (A.R.R. and J.A.S.) through a systematic search of the PubMed, Cochrane Library, Embase, Web of Science, PsycINFO, Scopus, Cumulative Index to Nursing and Allied Health Literature, Campbell Collaboration, and Education Resources Information Center databases. Using prespecified terms, we conducted electronic searches from inception through May 27, 2015, with no restrictions on language or setting (Web Appendix 1 and Web Table 1
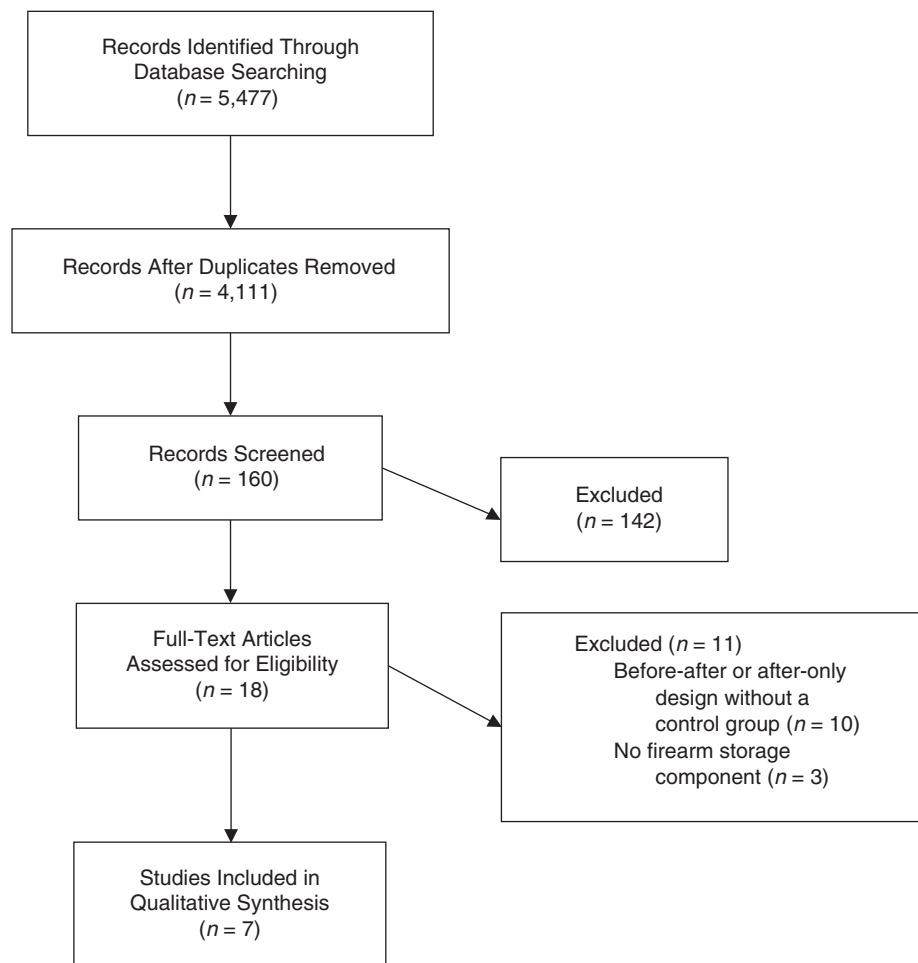

Figure 1. Flow diagram for identification, screening, and selection process of studies published in 2000–2012 and included in this review. Study selection was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses. For excluded studies, the subtotals exceed the total number because of overlapping features of studies.

available at http://aje.oxfordjournals.org/). Citations of identified papers and reviews were then hand searched to identify eligible records to supplement the electronic searches.

Study selection

The following eligibility criteria were used to select studies: 1) The study used a randomized or quasi-experimental controlled design; 2) the intervention included a component that promoted safe firearm storage by any means; and 3) the outcome included a measurable firearm storage practice such as keeping guns locked, storing guns unloaded, keeping ammunition locked, and/or storing ammunition in a separate location from guns. A "secure gun storage or safety device" is defined under 18 USC §921(a)(34) as 1) a device that, when installed on a firearm, is designed to prevent the firearm from being operated without first deactivating the device (e.g., trigger lock, cable lock); 2) a device incorporated into the design of the firearm that is designed to prevent the operation of the firearm by anyone not having access to the device; or 3) a safe, gun safe, gun case, lockbox, or other device that is designed to be or can be used to store a firearm and that is designed to be unlocked only by means of a key, a combination, or other similar means (42). Studies that used a before-after or after-only design without a control group were excluded. Identified records were first assessed for eligibility on the basis of title and abstract. Full manuscripts of potentially eligible abstracts and articles were then evaluated to determine whether the inclusion criteria were met. Study selection was performed independently by 2 reviewers (A.R.R. and J.A.S.).

Data extraction and study quality assessment

By use of a prespecified data extraction form, detailed information from all studies that met the inclusion criteria was collected and characterized largely in accord with the *Cochrane Handbook for Systematic Reviews of Interventions* (43) with the following items: 1) authors; 2) year of publication; 3) design; 4) unit of intervention; 5) setting; 6) population; 7) experimental intervention; 8) control intervention; 9) duration of follow-up; 10) outcomes; 11) findings; and 12) key conclusions.

We evaluated the quality of studies on the basis of the Cochrane Collaboration's domain-specific tool for assessing risk of bias (44). Using this tool, which is neither a score sheet nor a checklist, we made critical assessments for different quality domains, including selection, performance, detection, attrition, reporting, and other types of bias (Web Appendix 2). Although such biases are typically classified under 1 of 3 main groups of bias in epidemiologic research (i.e., selection bias, measurement error, and confounding), we use the terms proposed by the Cochrane Collaboration for consistency in language throughout this article. Results of quality assessment are presented as "low," "high," or "unclear" risk of bias for each domain separately on the basis of the following items: 1) random sequence generation; 2) allocation concealment; 3) blinding (separately for participants, study personnel, and outcome assessors); 4) incomplete outcome data; 5) selective reporting; and 6) other sources of bias. Two investigators (A.R.R. and J.A.S.) independently reviewed each article for quality and discussed discrepancies to reach a consensus in consultation with a third reviewer (F.P.R.).

Data synthesis and analysis

A 3-level cross-classification scheme was developed to categorize included studies. We used this classification to give a structured overview of all studies and to enhance the qualitative synthesis of information. First, studies were classified into 1 of the following 2 mutually exclusive categories: 1) those that used a randomized controlled design and 2) those that used a quasi-experimental controlled design. Second, within each of those categories, studies were classified into 1 of the following 2 mutually exclusive categories: 1) those that used individuals as the unit of intervention (e.g., individually randomized controlled trials) and 2) those that used groups of individuals as the unit of intervention (e.g., cluster-randomized controlled trials). We use the term "unit of intervention" instead of "unit of randomization" as not all included studies were randomized controlled trials. Third, within each of the 4 aforementioned categories, studies were further classified into 1 of the following 3 mutually exclusive categories (40): 1) those that provided both counseling and a safe firearm storage device; 2) those that provided counseling without a safe firearm storage device; and 3) those that provided a safe firearm storage device without counseling. We define the term "counseling" throughout this article as a structured set of educational messages or campaigns about safe firearm storage

Table 1. Cross-Classification of Included Studies Published in 2000–2012

First Author, Year (Reference No.)	Type of Intervention	Study Type
Carbone, 2005 (21)	Counseling with safe storage device provision	Group, quasi-experimental[a]
Barkin, 2008 (46)	Counseling with safe storage device provision	Group, randomized
Grossman, 2000 (20)	Counseling without safe storage device provision	Individual, randomized[a]
Stevens, 2002 (49)	Counseling without safe storage device provision	Group, randomized
Albright, 2003 (45)	Counseling without safe storage device provision	Individual, quasi-experimental
Sidman, 2005 (48)	Counseling without safe storage device provision	Group, quasi-experimental
Grossman, 2012 (47)	Safe storage device provision without counseling	Group, randomized

[a] "Individual" and "group" refer to the unit of intervention.

Table 2. Description and Findings of Included Studies Published in 2000–2012 by Type of Intervention

First Author, Year (Reference No.)	Study Design	Unit of Intervention	Study Setting	Study Population	Intervention Group	Control Group	Duration of Follow-up for Primary Analysis	Primary Outcomes	Findings	Key Conclusions
					Counseling With Safe Storage Device Provision					
Carbone, 2005 (21)	Two-arm, nonparallel group, quasi-experimental controlled trial	Family	Pediatric clinic located in an urban community health center in Tuscon, Arizona	Predominantly Hispanic families of children and adolescents attending clinic visits. Mean ages of children in the intervention and control groups were 6.5 and 5.9 years, respectively. Study was restricted to gun-owning families	Physician-delivered 1- to 2-minute gun safety verbal counseling + gun safety brochure + provision of free gunlock with instructions ($n = 73$ families)	Usual anticipatory guidance ($n = 78$ families)	One month. A total of 2,649 families completed the baseline survey; about 8% had firearms. Study was completed on 73% of original gun-owning families	Removal of all guns from home. Improvement in safe gun storage among households with guns at follow-up. Improvement in overall gun safety practices among all households	Removal of all guns from home: 22% intervention, 17% control; RR = 1.3 (95% CI: 0.7, 2.5). Improvement in safe gun storage among households with guns at follow-up: 51% intervention, 12% control; RR = 4.1 (95% CI: 2.1, 8.3). Improvement in overall gun safety practices among all households: 62% intervention, 27% control; RR = 2.3 (95% CI: 1.5, 3.4)	Office-based safe gun storage counseling supported with written information and a free gunlock resulted in significant improvements in safe gun storage behaviors but did not affect removal of firearms from home
Barkin, 2008 (46)	Two-arm, parallel group, randomized controlled trial	Practice	Pediatric clinics in 41 US states, Canada, and Puerto Rico participating in the practice-based research network of the American Academy of Pediatrics	Families (90% mothers) of children aged 2–11 years attending well-child pediatric clinic visits. Study was not restricted to gun owners, but safe firearm storage outcomes were analyzed only among gun owners	Physician-delivered, office-based violence prevention intervention using motivational interviewing with a component on safe firearm storage and provision of free cable gunlocks ($n = 68$ practices)	Usual care regarding injury/violence prevention + literacy promotion handout ($n = 69$ practices)	One and 6 months. Greater than 80% of eligible families participated across all sites	Change over time in self-reported use of firearm cable locks among gun owners	Using firearm cable locks—1 month: 64% intervention, 59% control; RD = 12% ($P = 0.006$); 6 months: 68% intervention, 54% control; RD = 22% ($P < 0.001$)	Office-based counseling supported with provision of free cable gunlocks significantly increased safe firearm storage among gun-owning families
					Counseling Without Safe Storage Device Provision					
Grossman, 2000 (20)	Two-arm, parallel group, randomized controlled trial	Practitioner	Nine urban and suburban family medicine and pediatric practices at Group Health Cooperative (a staff-model health maintenance organization) in western Washington	Gun-owning and non-gun-owning families of children and adolescents attending well-child visits. Mean ages of children in the intervention and control groups were 3.5 and 4.0 years, respectively	Practitioner-delivered verbal and written gun safety counseling and provision of coupons for obtaining 1 trigger lock and 1 lockbox at a discount for gun-owning families, and provided counseling to not acquire a gun for non-gun-owning families ($n = 29$ practitioners)	Usual practice ($n = 28$ practitioners)	3 months. A total of 2,082 eligible households approached; 1,673 (80%) kept appointment with practitioner during study period; of those, baseline and follow up data were collected on 1,292 (77%)	Removal of firearms from households among gun-owning families. Acquisition of a safe firearm storage device among gun-owning families. Acquisition of firearm among nongun-owning families	Removal of firearms from households: 6.7% intervention, 5.7% control; RD = 1.1% (95% CI: −0.4, 5.9). Acquisition of a safe firearm storage device: 27% intervention, 21% control; RD = 6.3% (95% CI: −1.3, 17.2). Acquisition of firearm among the entire study population: 1.3% intervention, 0.9% control ($P = 0.44$)	A single counseling session delivered during well-child visits combined with economic incentives to purchase safe storage devices did not lead to changes in household gun ownership or storage patterns

Table continues

Table 2. Continued

First Author, Year (Reference No.)	Study Design	Unit of Intervention	Study Setting	Study Population	Intervention Group	Control Group	Duration of Follow-up for Primary Analysis	Primary Outcomes	Findings	Key Conclusions
Stevens, 2002 (49)	Two-arm, parallel group, randomized controlled trial	Practice	Twelve pediatric primary care practices in mostly rural areas of New England, United States	Gun-owning and non-gun-owning families of fifth and sixth grade children attending pediatric well-child visits	Practitioner-delivered counseling about safety (including safe gun storage, seatbelts, and bicycle helmets); clinic site support (site visits, telephone calls, newsletters, and informational materials); and regularly scheduled printed materials mailed to families (n = 6 practices)	Practitioner-delivered counseling about alcohol and tobacco use; clinic site support (site visits, telephone calls, newsletters, and informational materials); and regularly scheduled printed materials mailed to families (n = 6 practices)	Visits at 12, 24, and 36 months; 90% (n = 3,145) of eligible families returned baseline survey with only 4% lost to follow-up and 1% withdrew over 36 months	Guns in home in locked storage	For storing guns unlocked, at 12 months: OR = 1.3 (95% CI: 0.9, 1.8); at 24 months: OR = 1.2 (95% CI: 0.8, 1.6); at 36 months: OR = 1.2 (95% CI: 0.9, 1.7)	Office-based safe gun storage counseling supported with long-term reinforcement did not improve locking of household guns
Albright, 2003 (45)	Three-arm, parallel group, quasi-experimental controlled trial	Patient	Urban, community-based, university-affiliated, family practice residency teaching clinic in Corpus Christi, Texas	Adults or families (mostly female and Hispanic; mean age = 45 years) of children attending clinic visits. The study was restricted to gun owners	Group intervention 1: gun ownership survey and verbal counseling on safe gun storage (n = 36 patients). Group intervention 2: gun ownership survey, verbal counselling, and written counseling on safe gun storage (n = 52 patients)	Gun ownership survey only (n = 39 patients)	60–90 days. Less than 0.5% of those with firearms in home refused participation	Improvement or decrement in safe gun storage practices as indicated by a change in practices from baseline to follow-up: locked guns, unloaded guns, no child access, or moving guns to a safer place	Made a safe change: 33% control, 64% group intervention 1, 58% group intervention 2. Made an unsafe change: 31% control, 22% group intervention 1, 31% group intervention 2	Office-based verbal counseling with or without written materials made a positive impact on safe firearm storage habits
Sidman, 2005 (48)	Two-arm, parallel group, quasi-experimental controlled trial	County	King County, Washington, and 9 other counties outside of Washington without child access prevention laws in 1996	Study area handgun-owning households with children in home	Gun safe storage community educational campaign consisting of television and radio announcements, billboards, community-distributed educational materials, and discount coupons for lockboxes (n = 1 county)	A total of 9 counties were combined into 1 group to serve as the referent	Two cross-sectional assessments in 1996 and 2001. A total of 13% of those contacted refused, 85% not eligible in 1996; similar numbers in 2001	Handgun-related outcomes: all stored with formal locking devices (trigger locks, lockboxes, or gun safes); all stored in lockboxes or gun safes; any stored loaded; any stored loaded without a formal locking device; any stored loaded and not in a lockbox or gun safe	Interyear odds ratios comparing 2001 vs. 1996—all stored with formal locking devices: ORs = 1.5 among intervention and 1.3 among control groups; all stored in lockboxes or gun safes: ORs = 1.7 among intervention and 1.7 among control groups; any stored loaded: ORs = 0.7 among intervention and 1.1 among control groups; any stored loaded without a formal locking device: ORs = 0.5 among intervention and 0.9 among control groups; any stored loaded and not in a lockbox or gun safe: ORs = 0.6 among intervention and 0.7 among control groups	A broad, educational community-based safe firearm storage campaign combined with economic incentives to purchase lockboxes did not improve safe storage practices

Table continues

Table 2. Continued

First Author, Year (Reference No.)	Study Design	Unit of Intervention	Study Setting	Study Population	Intervention Group	Control Group	Duration of Follow-up for Primary Analysis	Primary Outcomes	Findings	Key Conclusions
Safe Storage Device Provision Without Counseling										
Grossman, 2012 (47)	Two-arm, parallel group, randomized controlled trial	Household	Six villages in 2 different regions in western Alaska, United States	Gun-owning Alaska Natives (74% male), 73% with children in home, and all 19 years of age or older	Installation of free long gun cabinet and safety message about keeping all guns and ammunition locked in the cabinet (n = 129 households)	Using a "wait list" design, the control group received the intervention 12 months after baseline (n = 126 households)	12 months. Of 259 eligible households, 255 agreed to participate; approximately 84% and 81% of households recontacted at 12- and 18-month follow-up, respectively	Any guns unlocked. Ammunition unlocked. Any guns loaded and unlocked. Both guns and ammunition unlocked	Any guns unlocked: 35% intervention, 89% control ($P < 0.001$). Ammunition unlocked: 36% intervention, 84% control ($P < 0.001$). Any guns loaded and unlocked: 2% intervention, 9% control ($P = 0.065$). Both guns and ammunition unlocked: 23% intervention, 78% control ($P < 0.001$)	Installation of free long gun cabinets supported with safe gun storage messages improved the safe storage of guns and ammunition among rural Alaskan households

Abbreviations: CI, confidence interval; OR, odds ratio; RD, risk difference; RR, risk ratio.

delivered at the individual or community level. The counseling could be of any length, from minutes to months, depending on the study design.

No attempt to conduct a meta-analysis was made because of notable between-study heterogeneity in settings, populations, and interventions. This decision does not indicate that included studies had no commonalities. For instance, the majority of included studies used health-care provider-delivered messages among children, adolescents, and their families during clinic visits. Nonetheless, differences were sufficiently meaningful that we deemed a pooling of effect measures across studies unwise and uninformative.

RESULTS

Identified studies

Of 18 articles identified through the search followed by screening, 7 studies met all the inclusion criteria and were included in this review (Figure 1) (20, 21, 45–49). The 11 excluded articles had used a before-after or after-only design without a control group (19, 50–58) and/or lacked a firearm storage component (19, 54, 59). In addition, 2 articles were linked to the same quasi-experimental study (54, 56).

Table 1 presents the included studies using the 3-level cross-classification scheme. Four randomized controlled trials and 3 quasi-experimental controlled studies were included in this review (classification level 1). Two studies used individuals and 5 studies used groups as the unit of intervention (classification level 2). Two studies provided both counseling and a safe firearm storage device, 4 studies provided counseling without a safe firearm storage device, and 1 study provided a safe firearm storage device without counseling (classification level 3).

Intervention characteristics

Six studies provided a form of counseling. Five of those studies included health-care provider-delivered messages at family medicine or pediatric practices among adult patients or children, adolescents, and their families during clinic visits (Table 2). Such counseling typically included brief verbal and/or written messages; however, the content of those messages differed between studies. Three studies adapted material from the Steps to Prevent Firearm Injuries in the Home program (20, 21, 45). The Steps to Prevent Firearm Injuries in the Home program, developed jointly by the American Academy of Pediatrics and the Brady Center to Prevent Gun Violence, is an educational program designed to facilitate health-care provider-delivered counseling to patients regarding the inherent risk of guns in households and the community. The Steps to Prevent Firearm Injuries in the Home program kit included a health-care provider manual, family brochures, and educational posters. All 3 studies focused solely on safe firearm storage practices and provided 1- or 2-minute-long messages as part of the intervention. In the study by Grossman et al. (20), families without household firearms were counseled about the risks associated with access to household firearms and discouraged from introducing firearms into their household in the future. Families with household firearms were

counseled that the safest action for the entire family would be to remove guns from the household, and if they decided to keep firearms in their home they could reduce the risk of injury by storing them unloaded and in locked position. Additionally, coupons for obtaining 1 trigger lock and 1 lockbox at a discount were provided. The other 2 studies (21, 45) restricted attention to families with household firearms only and delivered the aforementioned message. In the study by Carbone et al. (21), participants in the intervention group received a free gunlock that was able to fit all handguns and long guns in all calibers and came with illustrated instructions.

Barkin et al. (46) specifically used motivational interviewing techniques to discuss children's access to firearms when parents expressed concern or if the provider was concerned after reviewing family behaviors. Motivational interviewing is a patient-centered counseling style that assesses interest and confidence in changing and elicits behavior change by helping patients explore and resolve ambivalence. In this study, motivational interviewing was part of a multicomponent intervention that was guided by social cognitive theory and emphasized modifying behavior through skills building for both the provider (counseling behavior) and patient (behaviors at home). Providers were specifically trained to apply motivational interviewing as part of the intervention. Safe firearm storage practice was only 1 of several behaviors assessed in this investigation as it also targeted other outcomes such as media use and discipline approaches. Providers offered tangible tools (minute timers for disciplinary timeouts and limiting media, as well as cable locks (as many as were requested), to store firearms more safely) to participants in the intervention arm.

The study by Stevens et al. (49) included both clinical practice and home interventions and was unique in that it was delivered over a 36-month period. The investigators modified the focus of well-child visits from screening and providing facts to engaging the child and parent in a joint conversation and encouraging communication about safe firearm storage. Study staff provided ongoing support to clinical sites after the initial office-based intervention using site visits, telephone calls, newsletters, and information materials and with regularly scheduled visual and printed materials mailed to the families. Safe firearm storage practice was 1 of several behaviors assessed in this investigation as it additionally targeted alcohol consumption, smoking, and bicycle helmet use.

The study by Sidman et al. (48) was the only investigation included in this review that focused on a community campaign. It used television and radio announcements, educational materials, and billboards to promote safe firearm storage. The campaign centered on the slogan, "Buy a Box for Your Gun, Not Your Kid." Educational materials bearing the slogan were often accompanied by a picture of an empty child-sized coffin or an unlocked cabinet containing a handgun and were distributed to physicians, clinics, nursing organizations, churches, schools, parent-teacher associations, and law enforcement offices. In addition, $10 coupons were provided for the purchase of $80 Cannon lockboxes (Cannon Safe, Inc., Las Vegas, Nevada) stocked by a major regional department store chain. The experimental community was King County, Washington, and the control communities included 9 counties outside of Washington State and west of the Mississippi River.

In the study by Grossman et al. (47), the intervention centered on the installation of a free long gun cabinet in households in rural villages in western Alaska. Up to 2 gun cabinets were installed along with instructions and a handout on use, a brief safety message about keeping all guns and ammunition locked in the cabinet, and instructions to keep the cabinet key in a secure location. The installer observed and certified that all guns and ammunition were secured in the cabinet after demonstrating its use. We did not consider this intervention to have included a form of counseling as previously defined; as such, it served as the only investigation in which the observed effect, if any, could reasonably be attributed to the provision of a safety device and not counseling in our opinion.

Intervention effects

A range of outcomes was evaluated in the studies (Table 2) mainly due to heterogeneity in the nature of interventions, as well as differences in the study populations and settings. Most studies restricted attention to gun-owning families and examined changes over time in safe firearm storage practices, such as keeping guns unloaded and locked, keeping ammunition locked and separate from firearms, removing access to guns by children, and moving guns to a safer place including removing them entirely from the household. There were investigations, however, in which the study population included non-gun-owning families (20); because outcomes pertaining to removal of guns from the household or use of a safety device did not apply to this subgroup, other outcomes such as acquisition of guns over the course of the study were assessed.

All 3 studies (21, 46, 47) in which a free safe firearm storage device was provided showed a significant improvement in safe storage practices (Table 2). In the study by Carbone et al. (21), families in the intervention group were more likely than those in the control group to have improved overall gun safety practices over the follow-up period (relative risk = 2.29, 95% confidence interval: 1.52, 3.44). In the study by Barkin et al. (46), households in the intervention group substantially increased (9.7%) in storing firearms with cable locks, while those in the control group decreased (−11.7%) their use of that device over the follow-up period (risk difference = 22%; $P < 0.001$). In the study by Grossman et al. (47), 35% of homes in the intervention group and 89% of those in the control group reported having any guns unlocked at follow-up ($P < 0.001$). An important feature of this study was that, unlike other investigations in which the outcomes were ascertained mainly by self-report, the outcome was also examined through direct observation; interviewers observed whether any guns or ammunition was visible outside a safe or cabinet around the interior of the home.

Among 4 studies (20, 45, 48, 49) in which no free safe firearm storage device was provided, only 1 (45) showed a significant improvement in safe firearm storage practices. Notably, 2 of those 4 studies (20, 48) provided economic incentives such as coupons for purchasing a safe firearm storage device; however, devices were not available for free and required the study participants to take additional steps to receive them, such as calling a toll-free number.

Table 3. Risk of Bias in Included Studies Published in 2000–2012 Using Cochrane Collaboration's Domain-Specific Tool for Quality Assessment

First Author, Year (Reference No.)	Random Sequence Generation	Allocation Concealment	Blinding[a]	Incomplete Outcome Data	Selective Reporting	Other Sources of Bias
Counseling With Safe Storage Device Provision						
Carbone, 2005 (21)	High. Nonrandom component based on a preselected order for intervention	High. Nonconcurrent groups with explicitly unconcealed procedures	Unclear. Insufficient information on whether outcome assessment was blinded	Unclear. Insufficient information on handling missing outcome data	Low. Published report includes all expected outcomes	Low. Other important sources of bias unlikely; specific analyses conducted to account for differences in safe storage between comparison groups at baseline
Barkin, 2008 (46)	Low. Computer-generated random assignment list	Low. Central allocation	Low. Unblinded but outcome assessment likely not influenced	Unclear. A large fraction of practices discontinued or were excluded; however, they were mostly balanced in numbers across 2 arms with somewhat similar, but not highly specific reason ("due to failure to collect eligible data")	Unclear. Published report includes information on main outcome (use of cable locks); however, a number of other safe firearm storage outcomes were measured and not reported	Low. Other important sources of bias unlikely
Counseling Without Safe Storage Device Provision						
Grossman, 2000 (20)	Low. Computer-generated random number	Unclear. Insufficient information on method of concealment	Unclear. Unblinded to participants and personnel but insufficient information on whether outcome assessment was blinded	Unclear. Equal proportions of intervention and control groups lost to follow-up, but reasons unclear	Unclear. Published report includes all expected primary outcomes; however, reporting of gun acquisition was not restricted to nongun owners (i.e., the third indicated outcome was not reported)	Low. Other important sources of bias unlikely
Stevens, 2002 (49)	Low. Computer-generated random number	Unclear. Insufficient information on method of concealment	Unclear. Insufficient information on whether outcome assessment was blinded	Unclear. Insufficient information on handling missing outcome data	Low. Published report includes all expected outcomes	Unclear. Insufficient information on strategies to minimize residual confounding by differences between comparison groups at baseline
Albright, 2003 (45)	High. Systematic nonrandom component based on preselected survey days	High. Rotation of survey days	Low. Outcome assessment was blinded	Low. 29 patients were lost to follow-up; sensitivity analyses did not materially change the results	Low. Published report includes all expected outcomes	Unclear. Insufficient information on strategies to minimize residual confounding by differences between comparison groups at baseline

Table continues

Table 3. Continued

First Author, Year (Reference No.)	Random Sequence Generation	Allocation Concealment	Blinding[a]	Incomplete Outcome Data	Selective Reporting	Other Sources of Bias
Sidman, 2005 (48)	High. Nonrandom component based on a preselected site for intervention	High. Explicitly unconcealed procedures	Unclear. Unblinded and insufficient information on whether it affected outcome assessment	Unclear. Insufficient information on handling missing outcome data	Low. Published report includes all expected outcomes	Unclear. Insufficient information on strategies to minimize residual confounding by differences between comparison groups at baseline; presence of local firearm safety initiatives in control counties during the study period
Safe Storage Device Provision Without Counseling						
Grossman, 2012 (47)	Low. Computer-generated random number	Low. Central allocation	Low. Unblinded but outcome assessment likely not influenced	Unclear. Insufficient information on handling missing outcome data; 19% intervention and 13% control households lost to follow-up at 12 months but reasons unclear	Low. Published report includes all expected outcomes	Low. Other important sources of bias unlikely

[a] As recommended by the Cochrane Collaboration, separated for 1) participants and personnel during the study and 2) outcome assessors.

Quality assessment

Overall, the included studies were of sufficiently high quality. Nonetheless, a wide range of risk of bias in different quality domains was observed (Table 3). Risk of selection bias was generally high for quasi-experimental controlled studies as the treatment assignment was not truly a random process and that allocation was not concealed (21, 45, 48). The risk of detection bias was unclear for several studies because the available information on blinding of outcome assessment was insufficient (20, 21, 48, 49). Some studies failed to report how incomplete outcome data were handled, leading to an unclear risk of attrition bias (20, 21, 46–49). Finally, a few investigations did not report characteristics of the study groups at baseline in sufficient detail leading to concerns about residual confounding, especially considering their relatively small sample size (45, 48, 49).

Despite these limitations, we believe that the large effect measures observed in studies that showed significant improvements in safe firearm storage practices make it unlikely that bias could explain the entirety of such associations. Some studies provided specific information to improve judgment about the potential effect of bias. For instance, Carbone et al. (21) acknowledged the limitations of a nonconcurrent design; nonetheless, they were not aware of any significant community gun-related program or event occurring during the study period that may have notably influenced their results. Likewise, some investigators noted the possibility of social desirability bias generated by participants' tendency to respond in an "acceptable" manner; however, the setting and nature of interventions coupled with the strength and direction of observed effects led them to conclude that their findings would be unlikely to have been dramatically distorted by such bias (45, 46).

DISCUSSION

Four of the 7 clinic- or community-based interventions included in this systematic review were effective at promoting safe firearm storage practices. A central finding of this systematic review is that all 3 studies (21, 46, 47) in which free devices were provided improved safe firearm storage practices. On the other hand, 2 interventions that provided economic incentives to acquire safe firearm storage devices were ineffective (20, 48). A serious need exists for additional high-quality randomized controlled trials of such interventions to inform policy and practice.

Studies included in this systematic review represent substantial progress over the past decade in the methodology used to design and evaluate safe firearm storage interventions. Another systematic review of safe firearm storage interventions published in 2003 (40) included only 1 randomized controlled trial and 6 before-after or after-only studies with no control group that had a number of methodological limitations. In that systematic review, 2 of 3 before-after studies (51, 52, 55) that assessed safe firearm storage interventions were effective, while another study (19) that evaluated firearm removal and acquisition among families with a depressed adolescent was ineffective. Both after-only studies (50, 53) demonstrated some firearm storage practices among participants; however, they were limited by small sample sizes.

Through our literature search, we also identified 3 safe firearm storage interventions (56–58) that were not included in either review (Web Table 2). Two after-only studies (56, 57) assessed firearm storage practices among adult gun owners exposed to a firearm-related public safety campaign, and 1 before-after investigation (58) examined a school-based program targeting gun-owning adults with children in the home. All 3 interventions were found to be effective. Overall, among all studies in the literature to date that assessed firearm storage interventions, 7 of 8 in which a free safe firearm device was provided were found to be effective (21, 46, 47, 51, 52, 56, 58). Notably, the eighth study (50) assessed the use of a free trigger lock without measuring overall safe firearm storage practices among law enforcement officers.

Considerations for future studies

That most studies offering a free safe firearm storage device were effective is consistent with an abundance of evidence regarding effectiveness of other health-care interventions (e.g., promoting medication or immunization adherence) in which removing economic and time barriers to follow clinical and public health recommendations has been shown to improve adherence (60–62). Given the relatively small cost of devices such as trigger locks, some of which are available for as little as $10, future interventions should strongly consider providing them to study participants. Knowledge regarding the impact of safe firearm storage promotion by type of device provision strategy (e.g., installing, handing out, mailing) or type of device (e.g., firearm cabinets, lockboxes, or cable or trigger locks) is quite limited and can be enhanced only through future comparative effectiveness studies.

Results from a 2004 survey showed that more than 20% of US individuals and households report owning more than 1 firearm, and approximately one half of firearm owners report owning more than 3 firearms (63). Interventions that do not provide a sufficient number of devices to secure *all* household firearms may find that individuals in the experimental group continue to report unsafe storage of *some* household firearms even if improvements in safe storage were made due to the intervention. This is particularly relevant given that the risk of self-inflicted firearm injuries is probably most dependent on the availability of a single firearm (64). Thus, interventions aimed at improving safe storage among only a limited number of household firearms may find that improvements in safe firearm storage do not ultimately lead to lower risk of firearm-related injury.

The safety of household firearm storage can be improved by keeping firearms unloaded and separate from locked ammunition, or locked, by using firearm cabinets, lockboxes, or cable or trigger locks. Future studies should develop and implement baseline and follow-up instruments that capture changes in each of those behaviors, as well as cumulative and overall improvements in safe firearm storage practices. Strategies to control for differences in baseline storage practices between study groups, especially in quasi-randomized and small randomized studies, are of utmost importance. Another consideration for future studies is whether to recommend the removal of firearms from the household, especially in households with individuals at high risk for self-inflicted injury

(e.g., those with substance use disorders or other suicide risk factors) (65, 66). Removal of household firearms likely confers the greatest firearm-related injury risk reduction given that several studies have suggested that firearm *availability* is more strongly associated with injury than firearm *accessibility* (64, 67). One potential method for promoting a balanced message is using materials from the Steps to Prevent Firearm Injuries in the Home program, as demonstrated in 3 of the studies included in this review (20, 21, 45). In those studies, families were counseled that the safest action would be to remove guns from the household, and if they chose to keep firearms in their home they could reduce the risk of injury by storing them unloaded and in locked position. However, recommendations to remove firearms from the home may enjoy less success than those promoting continued ownership with safe firearm storage (19, 20), and care should be taken in these discussions considering some firearm owners may prefer not to be asked to remove firearms from their homes (22, 23).

The effect of firearm interventions on non-firearm-owning individuals and families is also of importance. Firearm interventions may reinforce previous decisions not to acquire firearms or, as noted by Grossman et al. (20), may convince nonowners that safely storing firearms sufficiently decreases the risk of ownership thereby prompting a gun purchase. The outcome of interest in such studies would be the acquisition of firearms by nonowners and safe storage practices around newly acquired firearms. However, given that those outcomes are likely to be rare events, studies will require substantially larger study groups to have sufficient power to detect significant intervention effects.

An important aspect of the clinic-based intervention studies included in this review is that some individuals in the control group also received advice to safely store their firearms as a component of "usual care." For instance, 51% of control families in the study by Barkin et al. (46) discussed safe firearm storage with their provider. This is not surprising given that surveys have shown that firearm counseling is a common topic of discussion in some clinics, particularly in pediatrics (68, 69). Safe firearm storage intervention studies are typically pragmatic rather than explanatory in nature; therefore, the inclusion of a usual care arm is common and indeed desirable. This is an important consideration affecting decisions on sample size in safe firearm storage trials because the receipt of safety messages by control groups may result in a smaller intervention effect measure as a reflection of diminishing contrasts between study groups.

Motivations for firearm acquisition, ownership, and storage methods are complex, and little is known about such contextual factors or how they help to explain the effectiveness (or lack thereof) of safe firearm storage interventions. Most states have enacted some legislation mandating safer firearm storage in households with children (70); however, our knowledge on whether such laws and regulations truly influence storage practices is limited. Also, a large proportion of gun owners report keeping firearms for protection and voice concerns about delays in accessing a safely stored firearm during threatening situations (21, 51, 63). Additional studies are needed to determine whether the effectiveness of safe firearm storage interventions is modified by reasons for ownership or

perceived neighborhood safety. If such characteristics are shown to modify the intervention effect, future studies may consider the potential benefit of newly emerging "smart" firearm technologies, such as bracelets, watches, and implantable chips, that restrict the ability to discharge a firearm specifically to the owner (71), thereby allowing more immediate access to firearms while also reducing firearm-related injury risk to others in the household. Importantly, while smart technology is an encouraging development in the field of firearm safety, studies have not assessed whether using such technology decreases risk of firearm-related injury or whether such devices confer unique risks to firearm owners (e.g., device malfunction). The widespread acceptability of such technology to firearm owners is also unknown.

Studies promoting safe firearm storage may benefit from including theme analyses aimed at improving our understanding of the complex reasons for firearm ownership, how patients perceive study interventions, and the credibility of intervention staff. Such mixed-method studies may also be helpful in improving our understanding of how participants perceive discussions about risks associated with firearm ownership and access, and if such perceptions differ by whether children are present in the household. For instance, firearm owners without children may be less likely to be convinced of personal risk rather than risk for children. Given that a majority of firearm owners are male (63), including in dual-parent households (72), and that most participants in pediatric clinic-based intervention studies in this review were mothers, improving our understanding of household dynamics after firearm interventions may be enlightening. That there appears to be a gender gap in awareness of household firearm ownership and storage practices introduces yet another layer of complexity faced by firearm storage interventions (72, 73).

Modifying firearm storage behaviors may require approaching firearm owners using a framework similar to that used in addressing other complex health behaviors, such as chronic disease management and substance use disorders. With that in mind, safe firearm storage interventions may benefit from moving beyond basic safety messages by adopting motivational interviewing techniques similar to those used in the study by Barkin et al. (46), in which patient-centered counseling is used to elicit behavior change by exploring ambivalence surrounding behavior change and promoting patient-centered solutions. Although such strategies may prove to be more effective than basic safety messages, implementing motivational interviewing strategies is likely to be substantially more time and resource intensive as they often require provider training sessions and greater time commitment during clinical encounters; these are barriers that have impeded the implementation of motivational interviewing in other settings (74).

This systematic review included studies that sought to examine the effectiveness of safe firearm storage interventions without specification of the target population. However, of the 7 included studies, 5 specifically targeted households with children, and 41%–73% of households in the remaining studies had children present. This focus on children likely stems from a public consensus regarding the consequences of unsupervised access to firearms by children and a preexisting emphasis on injury prevention among pediatric practitioners and researchers. However, that safe storage is also associated with a lower risk of self-inflicted firearm injuries among adults (11, 15) suggests the need for studies to address safe firearm storage in households without children. Additionally, most studies in this systematic review targeted the general population in terms of participants' likelihood of safe firearm storage and overall suicide risk. Future studies may consider specifically testing such interventions among populations most likely to store firearms unsafely (e.g., individuals with substance use disorders) or those who may be most likely to benefit from firearm safety interventions (e.g., individuals with risk factors for self-inflicted or unintentional injury). Although observational studies have demonstrated that safe firearm storage is associated with lower risk of firearm injury and death (11, 13, 15, 35), a crucial next step is to assess firearm injury outcomes following safe firearm storage interventions. In the meantime, additional observational studies to assess the association between safe firearm storage and less frequently studied outcomes, such as unintentional or assault-related firearm injuries and deaths, would be valuable.

Additional opportunities for improvement in the methodological quality of studies that seek to examine safe firearm storage interventions do exist. Such studies should use a randomized controlled design whenever possible. To the extent possible, studies should be designed to be pragmatic in nature, utilizing nonrestrictive screening and inclusion criteria, and take into account issues of crossover, contamination, and the content of usual care. The conduct and reporting of such studies need to closely follow Consolidated Standards of Reporting Trials guidelines to ensure comprehensiveness and allow for comparison across studies (75). Several studies included in this systematic review failed to provide information on blinding of outcome assessment and did not report how incomplete outcome data were handled, leading to concerns about measurement error and selection bias. Studies that provide a safe firearm storage device typically rely on self-report of storage practices that may in turn introduce a strong potential for social desirability bias (a form of measurement error). Such bias is likely above and beyond a "baseline" social desirability associated with reporting firearm storage in general considering that those study participants indeed received a free device. Future studies can benefit from objective measurement of such practices (e.g., household inspection) as was done in the study by Grossman et al. (47) and by measuring the types of firearms present in each household (e.g., handgun, shotgun), as this may be indicative of reasons for firearm ownership (e.g., handgun for protection) and may help to explain intervention effectiveness. We call for creating a set of standards in measuring baseline and follow-up safe firearm storage practices in future trials. The number of household firearms and all components of safe firearm storage practice need to be accurately measured at baseline and follow-up points using the same instrument and assessors to allow for the comparison of participants' characteristics at baseline and alleviation of concerns about residual confounding. Such a measurement scheme would naturally lend itself to an appropriate analysis of change in each group that could in turn have desirable effects on the precision of effect measures.

We faced some limitations in the conduct of this systematic review. The number of studies meeting our inclusion criteria was small, as we included only studies that used a

randomized or quasi-experimental controlled design; however, it is notable that we found only a small number of studies of safe firearm storage interventions that used other designs (e.g., before-after, after-only). These small sample sizes highlight an urgent need to improve the current state of knowledge regarding safe firearm storage. The included studies varied in both design and risk of bias. Our cross-classification of studies according to their design was an attempt to organize the available information; however, the small number of studies included in each subgroup precluded our ability to compare the effectiveness in 1 subgroup of studies versus others. For the same reason, it was also not possible to examine the intervention effect measures stratified by the methodological quality of the included studies. Finally, the considerable heterogeneity of safe firearm storage interventions conducted to date precluded a meaningful pooling of findings across them. Considering the nature of such interventional studies, it is unlikely that an effect measure from a single firearm storage intervention can be readily applied to the variety of settings and populations in which firearm storage is relevant.

This systematic review meaningfully contributes to the evidence base regarding the effectiveness of interventions that promote safe firearm storage. Findings from additional methodologically sound randomized controlled trials are needed to inform evidence-based policy and practice for public health practitioners and clinicians in the future. The further development and implementation of effective gun safety interventions may require approaching firearm storage behaviors with the same attention to complexity as other health-care interventions addressing chronic disease management or substance use disorders. Future studies will benefit from focusing on individualized strategies to address firearm behavior change through acknowledging and addressing complex motivations for gun ownership and storage, removing economic and time barriers through providing free safe firearm storage devices directly, and adhering to rigorous methodological principles in the conduct and reporting of trials.

REFERENCES

1. National Center for Injury Prevention and Control, Centers for Disease Control and Prevention. Web-based Injury Statistics Query and Reporting System. http://www.cdc.gov/injury/wisqars. Updated July 13, 2015. Accessed July 20, 2015.
2. Children's Safety Network. The cost of firearm violence. http://www.childrenssafetynetwork.org/publications/cost-firearm-violence. Accessed July 20, 2015.
3. Cook PJ, Lawrence BA, Ludwig J, et al. The medical costs of gunshot injuries in the United States. *JAMA*. 1999;282(5):447–454.
4. Corso PS, Mercy JA, Simon TR, et al. Medical costs and productivity losses due to interpersonal and self-directed violence in the United States. *Am J Prev Med*. 2007;32(6):474–482.
5. Greenspan AI, Kellermann AL. Physical and psychological outcomes 8 months after serious gunshot injury. *J Trauma*. 2002;53(4):709–716.
6. Holbrook TL, Hoyt DB, Coimbra R, et al. Trauma in adolescents causes long-term marked deficits in quality of life: adolescent children do not recover preinjury quality of life or function up to two years postinjury compared to national norms. *J Trauma*. 2007;62(3):577–583; discussion 583.
7. Richmond TS, Kauder D, Schwab CW. A prospective study of predictors of disability at 3 months after non-central nervous system trauma. *J Trauma*. 1998;44(4):635–642; discussion 643.
8. Anglemyer A, Horvath T, Rutherford G. The accessibility of firearms and risk for suicide and homicide victimization among household members: a systematic review and meta-analysis. *Ann Intern Med*. 2014;160(2):101–110.
9. Brent DA, Perper JA, Allman CJ, et al. The presence and accessibility of firearms in the homes of adolescent suicides. A case-control study. *JAMA*. 1991;266(21):2989–2995.
10. Brent DA, Perper JA, Moritz G, et al. Firearms and adolescent suicide. A community case-control study. *Am J Dis Child*. 1993;147(10):1066–1071.
11. Conwell Y, Duberstein PR, Connor K, et al. Access to firearms and risk for suicide in middle-aged and older adults. *Am J Geriatr Psychiatry*. 2002;10(4):407–416.
12. Cummings P, Koepsell TD, Grossman DC, et al. The association between the purchase of a handgun and homicide or suicide. *Am J Public Health*. 1997;87(6):974–978.
13. Grossman DC, Mueller BA, Riedy C, et al. Gun storage practices and risk of youth suicide and unintentional firearm injuries. *JAMA*. 2005;293(6):707–714.
14. Kellermann AL, Rivara FP, Rushforth NB, et al. Gun ownership as a risk factor for homicide in the home. *N Engl J Med*. 1993;329(15):1084–1091.
15. Kellermann AL, Rivara FP, Somes G, et al. Suicide in the home in relation to gun ownership. *N Engl J Med*. 1992;327(7):467–472.
16. Wiebe DJ. Homicide and suicide risks associated with firearms in the home: a national case-control study. *Ann Emerg Med*. 2003;41(6):771–782.
17. Johnson RM, Coyne-Beasley T, Runyan CW. Firearm ownership and storage practices, U.S. households, 1992–2002. A systematic review. *Am J Prev Med*. 2004;27(2):173–182.
18. Karp A. Completing the count: civilian firearms. In: Berman E, Krause K, LeBrun E, et al, eds. *The Small Arms Survey: Guns and the City*. New York, NY: Cambridge University Press; 2007:39–66.
19. Brent DA, Baugher M, Birmaher B, et al. Compliance with recommendations to remove firearms in families participating in a clinical trial for adolescent depression. *J Am Acad Child Adolesc Psychiatry*. 2000;39(10):1220–1226.
20. Grossman DC, Cummings P, Koepsell TD, et al. Firearm safety counseling in primary care pediatrics: a randomized, controlled trial. *Pediatrics*. 2000;106(1 Pt 1):22–26.

21. Carbone PS, Clemens CJ, Ball TM. Effectiveness of gun-safety counseling and a gun lock giveaway in a Hispanic community. *Arch Pediatr Adolesc Med*. 2005;159(11): 1049–1054.

22. Forbis SG, McAllister TR, Monk SM, et al. Children and firearms in the home: a Southwestern Ohio Ambulatory Research Network (SOAR-Net) study. *J Am Board Fam Med*. 2007;20(4):385–391.

23. Webster DW, Wilson ME, Duggan AK, et al. Parents' beliefs about preventing gun injuries to children. *Pediatrics*. 1992; 89(5 Pt 1):908–914.

24. Stennies G, Ikeda R, Leadbetter S, et al. Firearm storage practices and children in the home, United States, 1994. *Arch Pediatr Adolesc Med*. 1999;153(6):586–590.

25. American Psychological Association. Gun violence: prediction, prevention, and policy. http://www.apa.org/pubs/info/reports/gun-violence-prevention.aspx. Accessed July 20, 2015.

26. Butkus R, Doherty R, Daniel H, et al. Reducing firearm-related injuries and deaths in the United States: executive summary of a policy position paper from the American College of Physicians. *Ann Intern Med*. 2014;160(12):858–860.

27. Dowd MD, Sege RD, Council on Injury, Violence, and Poison Prevention Executive Committee, et al. Firearm-related injuries affecting the pediatric population. *Pediatrics*. 2012;130(5): e1416–e1423.

28. National Rifle Association. Eddie Eagle Program. https://eddieeagle.nra.org. Accessed July 20, 2015.

29. National Shooting Sports Foundation. Safety and education. http://www.nssf.org/safety. Accessed July 20, 2015.

30. Guns & Ammo. G&A basics: how to store your gun. http://www.gunsandammo.com/home-featured/ga-basics-how-to-store-your-gun. Accessed July 20, 2015.

31. Haught K, Grossman D, Connell F. Parents' attitudes toward firearm injury prevention counseling in urban pediatric clinics. *Pediatrics*. 1995;96(4 Pt 1):649–653.

32. Barry CL, McGinty EE, Vernick JS, et al. After Newtown—public opinion on gun policy and mental illness. *N Engl J Med*. 2013;368(12):1077–1081.

33. Brent DA, Perper J, Moritz G, et al. Suicide in adolescents with no apparent psychopathology. *J Am Acad Child Adolesc Psychiatry*. 1993;32(3):494–500.

34. Shah S, Hoffman RE, Wake L, et al. Adolescent suicide and household access to firearms in Colorado: results of a case-control study. *J Adolesc Health*. 2000;26(3):157–163.

35. Shenassa ED, Rogers ML, Spalding KL, et al. Safer storage of firearms at home and risk of suicide: a study of protective factors in a nationally representative sample. *J Epidemiol Community Health*. 2004;58(10):841–848.

36. Vyrostek SB, Annest JL, Ryan GW. Surveillance for fatal and nonfatal injuries—United States, 2001. *MMWR*. 2004; 53(SS07):1–57.

37. Simon OR, Swann AC, Powell KE, et al. Characteristics of impulsive suicide attempts and attempters. *Suicide Life Threat Behav*. 2002;32(1 suppl):49–59.

38. de Moore GM, Plew JD, Bray KM, et al. Survivors of self-inflicted firearm injury. A liaison psychiatry perspective. *Med J Aust*. 1994;160(7):421–425.

39. Miller M, Azrael D, Hemenway D, et al. Firearm storage practices and rates of unintentional firearm deaths in the United States. *Accid Anal Prev*. 2005;37(4):661–667.

40. McGee KS, Coyne-Beasley T, Johnson RM. Review of evaluations of educational approaches to promote safe storage of firearms. *Inj Prev*. 2003;9(2):108–111.

41. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *J Clin Epidemiol*. 2009;62(10):e1–e34.

42. The US Government Printing Office. United States Code, 2009 edition. Title 18—crimes and criminal procedures. Part 1: crimes. Chapter 44: firearms. http://www.gpo.gov/fdsys/pkg/USCODE-2009-title18/html/USCODE-2009-title18-partI-chap44.htm. Accessed July 20, 2015.

43. The Cochrane Collaboration. Cochrane Handbook for Systematic Reviews of Interventions. http://handbook.cochrane.org. Accessed July 20, 2015.

44. Higgins JP, Altman DG, Gøtzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ*. 2011;343:d5928.

45. Albright TL, Burge SK. Improving firearm storage habits: impact of brief office counseling by family physicians. *J Am Board Fam Pract*. 2003;16(1):40–46.

46. Barkin SL, Finch SA, Ip EH, et al. Is office-based counseling about media use, timeouts, and firearm storage effective? Results from a cluster-randomized, controlled trial. *Pediatrics*. 2008;122(1):e15–e25.

47. Grossman DC, Stafford HA, Koepsell TD, et al. Improving firearm storage in Alaska native villages: a randomized trial of household gun cabinets. *Am J Public Health*. 2012; 102(suppl 2):S291–S297.

48. Sidman EA, Grossman DC, Koepsell TD, et al. Evaluation of a community-based handgun safe-storage campaign. *Pediatrics*. 2005;115(6):e654–e661.

49. Stevens MM, Olson AL, Gaffney CA, et al. A pediatric, practice-based, randomized trial of drinking and smoking prevention and bicycle helmet, gun, and seatbelt safety promotion. *Pediatrics*. 2002;109(3):490–497.

50. Coyne-Beasley T, Johnson RM. Law enforcement officers' opinions about gun locks: anchors on life jackets? *Inj Prev*. 2001;7(3):200–204.

51. Coyne-Beasley T, Schoenbach VJ, Johnson RM. "Love our kids, lock your guns": a community-based firearm safety counseling and gun lock distribution program. *Arch Pediatr Adolesc Med*. 2001;155(6):659–664.

52. Horn A, Grossman DC, Jones W, et al. Community based program to improve firearm storage practices in rural Alaska. *Inj Prev*. 2003;9(3):231–234.

53. Kruesi MJ, Grossman J, Pennington JM, et al. Suicide and violence prevention: parent education in the emergency department. *J Am Acad Child Adolesc Psychiatry*. 1999;38(3): 250–255.

54. Meyer G, Roberto AJ, Atkin CK. A radio-based approach to promoting gun safety: process and outcome evaluation implications and insights. *Health Commun*. 2003;15(3): 299–318.

55. Oatis PJ, Fenn Buderer NM, Cummings P, et al. Pediatric practice based evaluation of the Steps to Prevent Firearm Injury program. *Inj Prev*. 1999;5(1):48–52.

56. Roberto A, Meyer G, Johnson AJ, et al. Promoting gun trigger-lock use: insights and implications from a radio-based health communication intervention. *J Appl Commun Res*. 2002; 30(3):210–230.

57. Vogel RE, Dean C. The effectiveness of a handgun safety education program. *J Police Sci Adm*. 1986;14(3):242–249.

58. Wargo C, Erdman DA, Smith JG, et al. Community gun safety in Central Pennsylvania. *J Trauma Nurs*. 2013;20(1):67–73.

59. Howard PK. Evaluation of age-appropriate firearm safety interventions. *Pediatr Emerg Care*. 2005;21(7):473–479.

60. Ohrt CK, McKinney WP. Achieving compliance with influenza immunization of medical house staff and students. A randomized controlled trial. *JAMA*. 1992;267(10):1377–1380.

61. Choudhry NK, Avorn J, Glynn RJ, et al. Full coverage for preventive medications after myocardial infarction. *N Engl J Med*. 2011;365(22):2088–2097.
62. Osterberg L, Blaschke T. Adherence to medication. *N Engl J Med*. 2005;353(5):487–497.
63. Hepburn L, Miller M, Azrael D, et al. The US gun stock: results from the 2004 National Firearms Survey. *Inj Prev*. 2007;13(1): 15–19.
64. Dahlberg LL, Ikeda RM, Kresnow MJ. Guns in the home and risk of a violent death in the home: findings from a national study. *Am J Epidemiol*. 2004;160(10):929–936.
65. Arsenault-Lapierre G, Kim C, Turecki G. Psychiatric diagnoses in 3275 suicides: a meta-analysis. *BMC Psychiatry*. 2004;4:37.
66. Simonetti JA, Mackelprang JL, Rowhani-Rahbar A, et al. Psychiatric comorbidity, suicidality, and in-home firearm access among a nationally representative sample of adolescents. *JAMA Psychiatry*. 2015;72(2):152–159.
67. Brent DA, Perper JA, Goldstein CE, et al. Risk factors for adolescent suicide. A comparison of adolescent suicide victims with suicidal inpatients. *Arch Gen Psychiatry*. 1988;45(6): 581–588.
68. Solomon BS, Duggan AK, Webster D, et al. Pediatric residents' attitudes and behaviors related to counseling adolescents and their parents about firearm safety. *Arch Pediatr Adolesc Med*. 2002;156(8):769–775.
69. Olson LM, Christoffel KK, O'Connor KG. Pediatricians' involvement in gun injury prevention. *Inj Prev*. 2007;13(2): 99–104.
70. Smart Gun Laws. Child access prevention policy summary. http://smartgunlaws.org/child-access-prevention-policy-summary. Accessed July 20, 2015.
71. Cook PJ, Leitzel JA. "Smart" guns: a technological fix for regulating the secondary market. *Contemp Econ Policy*. 2002; 20(1):38–49.
72. Azrael D, Miller M, Hemenway D. Are household firearms stored safely? It depends on whom you ask. *Pediatrics*. 2000; 106(3):E31.
73. Coyne-Beasley T, Baccaglini L, Johnson RM, et al. Do partners with children know about firearms in their home? Evidence of a gender gap and implications for practitioners. *Pediatrics*. 2005; 115(6):e662–e667.
74. Amodeo M, Lundgren L, Cohen A, et al. Barriers to implementing evidence-based practices in addiction treatment programs: comparing staff reports on motivational interviewing, adolescent community reinforcement approach, assertive community treatment, and cognitive-behavioral therapy. *Eval Program Plann*. 2011;34(4):382–389.
75. Schulz KF, Altman DG, Moher D, et al. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. *J Clin Epidemiol*. 2010;63(8):834–840.