Lethal means reduction: what have we learned?

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Purpose of review

Suicide is an important global public health problem. Across nations, suicide rates are linked to the availability of lethal means. Three methods dominate country-specific suicide rates: firearms, pesticides, and hanging. There is increasing international support for reducing the availability of lethal means to prevent suicide. This article reviews evidence regarding lethal means reduction as a suicide-prevention strategy.

Recent findings

Most evidence in support of means reduction comes from ecological studies examining the association between population-level decreases in the availability of a given lethal means of suicide and method-specific suicide rates. Substantial declines in method-specific suicide rates were shown following reductions in availability of lethal means through initiatives such as the passage of firearm control laws, detoxification of domestic gas, modification of drug packaging and toxicity, and installation of barriers at jump sites. The vast majority of the evidence for the effectiveness of lethal means reduction relates to reducing the availability of firearms and pesticides.

Summary

Implementing means reduction at both the population and individual levels poses many challenges, particularly when political issues arise during regulation of firearms or pesticides. Nevertheless, evidence strongly suggests that means reduction is effective and should be an important part of a suicide-prevention strategy.

Keywords

firearms, lethal means, means reduction, means restriction, pesticides, suicide prevention

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Introduction

There is increasing support for reducing the availability of lethal means as a strategy for preventing suicide in the United States and throughout the world [1•]. Means reduction was recommended in the U.S. Department of Health and Human Services' *National Strategy for Suicide Prevention* [2], the Institute of Medicine's *Reducing Suicide: A National Imperative* [3], the WHO's *World Report on Violence and Health* [4], and the Centers for Disease Control and Prevention's (CDC) *CDC Injury Research Agenda* [5]. The purpose of this article is to describe the science regarding lethal means reduction as a suicide-prevention strategy.

Lethal means as a strategy for suicide prevention

Suicide is an important public health problem in the United States and around the globe [4,6••]. The suicide rate in a given location is linked to the availability of lethal means with which to commit suicide [1•]. Three methods dominate country-specific suicide rates: firearms, pesticides, and hanging [1•]. In the United States, where firearms – a highly lethal means of suicide – are common, suicide is the third leading cause of death among 15–24-year-olds. Nearly half of those suicides are committed with firearms [7•,8,9]. The most commonly used means of suicide are different in other countries where firearms are less common. Poisoning is a leading cause of suicide, from toxic pesticides in Asian and Latin American countries, and from drugs in European countries. Jumps from high places are a leading cause of suicide death in some cities, including Hong Kong [1•,4,10].

Given that access to lethal means is associated with suicide, it follows that decreasing availability may be an important preventive strategy. Referred to as 'means reduction', the idea is to separate, in time and space, a particularly lethal means with which to commit suicide from those who would attempt suicide. This includes strategies such as reducing access to firearms for those at high-risk for suicide, or installing barriers at jump sites [2]. Means reduction prevents suicide primarily through reducing the lethality of suicidal behavior. Notably, not

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all means of suicide are equally amenable to prevention via a means reduction approach. It is relatively easier, for example, to prevent poisoning suicide by regulating drug prescribing practices than to prevent hanging suicides by regulating items used in strangulation asphyxia.

Central to the effectiveness of means reduction is the fact that many suicide attempts are made impulsively during a short-term period of heightened vulnerability, and so the availability of lethal means in those moments contributes to suicidal behavior. In a study of 15–34-year-olds who had made a nearly-lethal suicide attempt, authors found that 24% reported that the interval between deciding to commit suicide and making the attempt was less than 5 min [11]. A similar result was found in a more recent study of patients in a psychiatric hospital; about one-half said they contemplated suicide for 10 min or less before their attempt [12••]. Having limited access to lethal means of suicide increases the chances that a young person will not attempt suicide, or will attempt suicide with a more readily available but less lethal method, thereby increasing the chance for survival.

Means reduction can occur on a population or on an individual level. Population-level means reduction is when a given means becomes less available or completely unavailable due to trends or policy changes. A noteworthy example is when the amount of carbon monoxide in the domestic gas supply in the United Kingdom was reduced. The percentage of carbon monoxide decreased from 13% in 1955 to 0% in 1975, and the poisoning suicide rate dropped commensurately [13]. Individual-level approaches to means reduction involve limiting access to a particular means for a targeted group of people, for example, when parents remove a firearm from their home because their child is judged to be at high-risk for suicide. Both levels have advantages and disadvantages. Population-level means reduction strategies have greater reach, but are difficult to carry out. Although individual-level strategies tend to be more politically feasible, they have limited reach and success depends on the compliance of individuals.

Evidence base

In a systematic review of the literature on effectiveness of suicide interventions, an international expert panel concluded that means reduction was one of only two approaches with a strong evidence base [6••]. Notably, the other strategy was physician recognition and treatment for depression. Most of the evidence in support of means reduction comes from ecological studies examining the association between a population-level decrease in the availability of a given lethal means of suicide and method-specific suicide rates. Substantial declines in method-specific suicide rates were shown following reductions in the availability of lethal means through initiatives such as the passage of firearm control laws, detoxification of domestic gas, modification of drug packaging and toxicity, and installation of barriers at jump sites [6••]. Since the publication of that influential review, the evidence that lethal means reduction contributes to declines in suicide has continued to grow. In Denmark, restrictions on the availability of toxic domestic gas and barbiturates were associated with a substantial decline in suicides by poisonings from 1970–2000 [14]. In the United States, changes in drug prescription practices, particularly the increased use of selective serotonin reuptake inhibitors (SSRIs), a less toxic and less lethal antidepressant than tricyclic antidepressants (TCAs), may be associated with a decrease in suicide. Gibbons *et al.* [15] report that increases in prescriptions for SSRIs and other new-generation non-SSRIs relative to TCAs are associated with lower suicide rates both between and within the US counties over time and may reflect antidepressant efficacy, compliance, a better quality of mental healthcare, and low toxicity in the event of a suicide attempt by overdose. However, most of the new evidence for the effectiveness of lethal means reduction relates to reducing the availability of firearms and certain pesticides [10,14,16,17].

Firearms

Research shows that both declines in firearm ownership and passage of firearm policies that impose restrictions on access are associated with decreased rates of firearm suicide. The pathway is that laws and changes in social norms contribute to reductions in the availability of firearms, which, in turn, reduces the firearm suicide rate [17]. In a study tracking household firearm ownership and suicide rates in the United States from 1986–2002, Miller *et al.* [16] found that a 10% decline in firearm ownership was associated with statistically significant declines in the suicide rate. This is important because the number of households with firearms in the United States is on the decline [18]. A significant decline in suicides among women ranging from 20 to 64 years and among men older than 20 years of age was seen in Austria following enactment of stringent firearm laws, which specified safe storage regulations and a 3-day waiting period for firearms, and which also required purchasers to be 21 years of age, undergo a background check and psychological testing, and specify a reason for firearm ownership [17].

Klieve *et al.* [19••] re-examined data on the effect of the 1996 National Firearms Agreement (NFA) in Australia on suicides among men. The NFA imposed strong restrictions on access and storage of firearms. Although their data show that firearm suicides declined following implementation of NFA, there are two caveats worth mentioning. First, the data show that firearm suicides had been on the decline even before passage of the NFA. The authors

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suggest that this may have been due to the fact that many Australians were migrating from rural areas to cities, where firearm ownership is less common. Thus, firearm ownership was declining, and firearm suicide along with it. This finding has similarities to that of Miller *et al.* [16], discussed above. Second, the authors found that the method of suicide varied with age, with younger decedents hanging themselves and older decedents using firearms. They hypothesize that the cohort effect may reflect that the older generation had more familiarity with firearms, having experienced World War II. Reductions in firearm availability have been shown to be particularly effective for older adults in other studies as well [20].

Pesticides

Self-poisoning with certain commonly-used pesticides is highly lethal [21,22•]. In 2002, pesticide self-poisonings accounted for at least 30% of all suicides around the world [21]. Pesticide self-poisoning is the most common means of suicide in many countries [21]; and it accounts for 21% of suicide deaths in south-east Asia [21,23•]. Mann *et al.*'s [6••] international systematic review showed decreases in pesticide self-poisonings following regulations on pesticides in Finland and Western Samoa. Recent data show a similar decrease in Sri Lanka, where pesticide self-poisoning had been the leading cause of suicide since the 1960s, contributing to more than 35 deaths per 100 000 persons in 1995. The self-poisoning suicide rate declined by more than 50% following bans on the most toxic pesticides [10,24].

Limitations

Although there is strong evidence supporting means reduction as a strategy for suicide prevention, there are notable limitations in the research. Most of the evidence comes from ecological studies; this is concerning because this study design provides limited support for causality as compared with randomized controlled trials. The relative infrequency of suicide, in conjunction with ethical concerns and the population-level of many lethal means reduction initiatives pose significant barriers to using trials to evaluate means reduction. Nonetheless, adequately powered, population-based studies are needed to assess how specific means reduction strategies affect suicide rates [9].

Importantly, there are a number of quasi-experimental studies demonstrating that access to firearms on an individual level is a strong risk factor for suicide in the United States [25–30]. Those studies have been criticized because of the possibility that a third unmeasured variable, mental illness, drives the observed association between firearms and suicide, undermining the conclusion that firearms themselves contribute to suicide [31]. Two recent studies have shown that firearms owners are no more likely than nonowners to have a history of mental health problems, a strong challenge to the third variable hypothesis [32,33]. The well established relationship between firearm access and suicide rates, then, does not seem to be because firearm owners are more likely than nonfirearm owners to be mentally ill or suicidal. Rather, a more likely explanation is that those with access to firearms at home who do become suicidal are more likely to die in an attempt than those without such access.

Planned efforts to reduce access to lethal means

The evidence in support of lethal means reduction as a suicide-prevention strategy has not often come from planned interventions, but rather from changes in national or local policies, practices, or social norms. For example, detoxification of domestic gas happened in the United Kingdom because of changes in manufacturing [13]. The use of means reduction as a planned intervention has not been widespread, but when employed it has been sensibly targeted to those means most commonly used by local populations [6••]. In the past few years, lethal means reduction research has focused on reducing access to firearms through safer storage and patient education, and reducing access to pesticides through safer storage [1•,4,5,34•,35,36•].

Pesticides

Interventions in Sri Lanka demonstrated community support for keeping pesticides locked up in boxes that had been distributed by researchers [34•,35,36•]. At the 7-month follow-up interview in a pilot study, 82% of residents in the intervention community were using the boxes, up from 2% at baseline [35]. Although compliance decreased over time, more than half were using the boxes 2 years later [34•,36•]. As these studies were not designed to assess whether safe storage of pesticides resulted in fewer suicides, further research on this matter is warranted.

United States efforts to reduce access to firearms and other lethal means

In the United States, where firearms are the leading method of suicide and where one-third of homes contain a firearm [8], professionals promote working with family members to reduce an individual's access to firearms if he or she is going through a suicidal crisis, or is otherwise deemed to be at high-risk for suicide. A determination of high-risk is a judgment call, but may include depression, substance use problems, conduct disorder, previous suicide attempts, self-harm, or mental health diagnoses. Counseling on reducing access to firearms and other lethal means (e.g., certain drugs) are particularly important for pediatric suicide and injury prevention; it is strongly recommended by the American Academy of Pediatrics [37].

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Interventions by research teams led by Dr David Brent and Dr Markus Kruesi suggest that caretakers exposed to means reduction counseling were more likely than those not exposed to reduce access [38,39]. Kruesi's emergency department-based means restriction education program is catalogued as effective by the 'Evidenced-Based Suicide Prevention Project' [40]. Another study showed that anticipatory guidance by pediatricians resulted in an increase in safe firearm storage practices [41•]. This is an important finding because research by Grossman *et al.* [26] shows that firearms that are stored securely, that is, stored unloaded and locked up, are significantly less likely to be used by an adolescent to commit suicide. As with safe pesticide storage, more research is needed to determine the extent to which counseling on reducing access to lethal means prevents suicides.

Unfortunately, research suggests that practitioners do not consistently assess for youth's access to firearms and other lethal means [42–44,45•]. Grossman *et al.* showed that only 28% of emergency department (ED) nurses in Illinois had provided education to patients' caregivers about reducing access to lethal means of suicide at home, even though 80% of them had recent experience with suicidal youth [42]. In another study, researchers interviewed caretakers who had contacted a poison control center following a deliberate drug overdose by an adolescent. Only 12% of those with medications at home and none with firearms at home reported receiving counseling from ED personnel about reducing the adolescent's access to potential means of suicide [43].

Many have noted the barriers to counseling on reducing access to lethal means; these include the belief that it does not work, low self-efficacy, concerns about reactions, and insufficient time [41•,42,44,45•,46••]. Increased training to enhance skills related to counseling on reducing access to lethal means has been recommended; education can be accomplished in professional training programs (e.g., medical residency), workshops, and journal articles that provide advice, such as the one by Dr Robert Simon [46••,47–49,50••]. One promising channel for education is distance learning through the internet via the National Center for Suicide Prevention Training (NCSPT) [49]. NCSPT currently has four workshops relating to different aspects of suicide prevention on the internet, and an additional workshop focused on counseling to reduce access to lethal means will soon be available (http://training.sprc.org).

Hanging

In this review of the literature on means reduction, suicide by hanging has been conspicuously absent, despite that it is the most common method of suicide in many countries and contributes to more than one-third of the world's suicides [1•]. An important future consideration is whether a means reduction approach can be applied to hanging. On the one hand, the materials used include everyday household items, such as bed sheets, belts, or dog leashes, making it difficult to monitor means. On the other hand, creating a suicide-safe environment is standard practice in hospital and correctional facilities. This includes eliminating or minimizing hanging points and restricting access to items that could be used in a hanging [51].

Ongoing monitoring of suicide trends and availability of means

An international panel of experts recommended monitoring trends in suicide to 'recognize early on the possibility of substitution of methods' [6••]. It is difficult to investigate whether someone whose access to a specific means is restricted will use another method to commit suicide. The best evidence suggests that, on an individual level, method substitution is unlikely. This is particularly true for those with high ambivalence about suicide [52]. One reason substitution unlikely is that people are drawn to specific methods because of preferences about things like how they want to be found, pain tolerance, and what means they are comfortable using [52].

It is equally difficult to assess the extent to which one method will displace another method following a population-level change in the availability of means [52]. This has relevance for suicide by hanging, as some of the decrease in suicides by means that are made unavailable may result in an increase in rates of suicide by hanging [1•,52,53]. After restrictions on firearm ownership were imposed in Australia, the firearm suicide death rate decreased, but the hanging suicide death rate increased. However, the pathways of influence are confounded because hanging suicide rates were on the rise before the restrictions were passed [19••]. Importantly, the overall suicide rate decreased, highlighting that means reduction remains an important strategy for suicide prevention, and not just for method-specific suicide prevention. Having highly lethal means readily available facilitates impulsive and unplanned suicidal acts, many of which would not happen, or would not be fatal, in the absence of those methods [1•].

It is also important to monitor the availability of lethal means within populations. As decreases in the availability of lethal means contribute to decreases in the suicide rates, increases in the availability of highly lethal means can result in increases in suicide rates. Africa and the Middle East have increasing pesticide sales; health officials should pay close attention to trends in pesticide self-poisoning suicides in those regions [21].

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Conclusion

The evidence strongly suggests that means reduction is effective and should be an important part of a suicide-prevention strategy. However, implementing means reduction at both the population and individual levels poses many challenges, particularly because political issues arise when trying to regulate firearms or pesticides. Furthermore, trying to restrict access to items that could be used in hanging, and to eliminate or minimize hanging points in the home is complex. In addition to research on the effectiveness of lethal means reduction, research that takes the complicated political landscape and home environment into account is needed in order for means reduction to be a feasible undertaking for families, communities, and professionals.

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There are no conflicts of interest.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- • of special interest
- •• of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (pp. 000–000).

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