Suicide prevention strategies revisited: 10-year systematic review

Gil Zalsman, Keith Hawton, Danuta Wasserman, Kees van Heeringen, Ella Arensman, Marco Sarchiapone, Vladimir Carli, Cyril Höschl, Ran Barzilay, Judit Balazs, György Purebl, Jean Pierre Kahn, Pilar Alejandra Sáiz, Cendrine Bursztein Lipsicas, Julio Bobes, Doina Cozman, Ulrich Hegerl, Joseph Zohar

Summary

Background Many countries are developing suicide prevention strategies for which up-to-date, high-quality evidence is required. We present updated evidence for the effectiveness of suicide prevention interventions since 2005.

Methods We searched PubMed and the Cochrane Library using multiple terms related to suicide prevention for studies published between Jan 1, 2005, and Dec 31, 2014. We assessed seven interventions: public and physician education, media strategies, screening, restricting access to suicide means, treatments, and internet or hotline support. Data were extracted on primary outcomes of interest, namely suicidal behaviour (suicide, attempt, or ideation), and intermediate or secondary outcomes (treatment-seeking, identification of at-risk individuals, antidepressant prescription or use rates, or referrals). 18 suicide prevention experts from 13 European countries reviewed all articles and rated the strength of evidence using the Oxford criteria. Because the heterogeneity of populations and methodology did not permit formal meta-analysis, we present a narrative analysis.

Findings We identified 1797 studies, including 23 systematic reviews, 12 meta-analyses, 40 randomised controlled trials (RCTs), 67 cohort trials, and 22 ecological or population-based investigations. Evidence for restricting access to lethal means in prevention of suicide has strengthened since 2005, especially with regard to control of analgesics (overall decrease of 43% since 2005) and hot-spots for suicide by jumping (reduction of 86% since 2005, 79% to 91%). School-based awareness programmes have been shown to reduce suicide attempts (odds ratio [OR] 0·45, 95% CI 0·24–0·85; p=0·014) and suicidal ideation (0·5, 0·27–0·92; p=0·025). The anti-suicidal effects of clozapine and lithium have been substantiated, but might be less specific than previously thought. Effective pharmacological and psychological treatments of depression are important in prevention. Insufficient evidence exists to assess the possible benefits for suicide prevention of screening in primary care, in general public education and media guidelines. Other approaches that need further investigation include gatekeeper training, education of physicians, and internet and helpline support. The paucity of RCTs is a major limitation in the evaluation of preventive interventions.

Interpretation In the quest for effective suicide prevention initiatives, no single strategy clearly stands above the others. Combinations of evidence-based strategies at the individual level and the population level should be assessed with robust research designs.

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Geha Mental Health Center and Sackler School of Medicine, Tel Aviv University, Tel Aviv, Israel (G Zalsman MD, R Barzilay MD); **Division of Molecular Imaging and Neuropathology, Department of Psychiatry, Columbia University, New York, NY, USA** (G Zalsman); **Centre for Suicide Research, University of Oxford, Oxford, UK** (K Hawton FMedSci); **National Centre for Suicide Research and Prevention of Mental Ill-Health (NASP), Karolinska Institute, Stockholm, Sweden** (D Wasserman MD, V Carli MD); **Unit for Suicide Research, Ghent University, Ghent, Belgium** (K van Heeringen MD); **National Suicide Research Foundation, Department of Epidemiology and Public Health, University College Cork, Cork, Ireland** (E Arensman PhD); **Department of Medicine and Health Science, University of Molise, Via De Santis Campobasso and National Institute for Health, Migration and Poverty, Roma, Italy** (M Sarchiapone MD); **National Institute of Mental Health, Klecany, Czech Republic** (C Höschl MD); **Department of Developmental and Clinical Child Psychology, Institute of Psychology, Eotvos Lorand University, Budapest, Hungary** (J Balazs MD); **Institute of Behavioral Sciences, Semmelweis University Budapest, Budapest, Hungary** (G Purebl MD); **Université de Lorraine, Pôle de Psychiatrie et Psychologie Clinique, Centre Psychothérapique de Nancy-Laxou, Nancy-Laxou, France** (J P Khan MD); **Department of Psychiatry,**

Introduction

Over 800 000 people worldwide die each year by suicide,[1] accounting for 1·4% of deaths worldwide. Suicide can occur at any point in the lifespan, and is the second most frequent, and in some countries the leading, cause of death among young people aged 15–24 years.[1] In addition, around 20–30 times as many suicide attempts occur.[2]

Suicide occurs because of a convergence of genetic,[3] psychological,[4] social, and cultural risk factors, combined with experiences of trauma and loss.[5] Internal or external risk factors and the relations between them can be explained in models of suicide, such as stress–diathesis,[6] gene–environment,[7] and gene–environment and timing interactions.[8]

The complexity of this multifaceted phenomenon and low base rates, make research on suicide prevention highly challenging.[9] However, the recognition of suicide prevention as a public health priority[10] and national prevention programmes have encouraged research, detection, treatment, and management of people at risk for suicide in many countries.[11,12] A major review of the effectiveness of approaches to suicide prevention was done by Mann and colleagues in 2005.[13] We did a systematic review using similar methodology to assess progress in suicide prevention research since that influential study.

Methods

Search strategy

We searched PubMed and the Cochrane library for all relevant English language studies published between Jan 1, 2005, and Dec 31, 2014. The initial search used the Medical Subject Headings identifiers for "suicide" (including the subheadings "suicide, attempted", and

University of Oviedo, Centro de Investigación Biomédica en Red de Salud Mental, CIBERSAM Oviedo, Spain (P A Sáiz MD, J Bobes MD); **Department of Community Mental Health, Faculty of Social Welfare and Health Sciences, University of Haifa, Haifa, Israel** (C B Lipsicas PhD); **Department of Clinical Psychology, "Iuliu Hatieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania** (D Cozman MD); **Department of Psychiatry and Psychotherapy, University of Leipzig, Leipzig, Germany** (U Hegerl PhD); **and Psychiatry Department, Sheba Health Center and Sackler School of Medicine, Tel Aviv University, Tel Avis, Israel** (J Zohar MD)

Correspondence to: Gil Zalsman, Geha Mental Health Center and Psychiatry Department, Tel Aviv University, Petach Tiqwa 49100, Israel **zalsman@post.tau.ac.il**

Research in context

Evidence before this study

We reviewed evidence for the effectiveness of suicide prevention interventions published since Mann and colleagues' review in 2005. We searched PubMed and the Cochrane library systematically for all relevant English language studies published between Jan 1, 2005, and Dec 31, 2014. See Methods for details. We selected studies reporting completed suicide, attempted suicide, and suicidal ideation, as well as studies reporting intermediate outcomes including help-seeking behaviour or identification of at-risk individuals. This produced 164 publications, which were categorised for their level of evidence according to the Oxford criteria.

Added value of this study

Research published since 2005 strengthens the evidence base in several areas of suicide prevention. Restricting access to lethal means can clearly prevent suicide. There have been significant results of school-based awareness programmes in reducing suicide attempts and ideation. The anti-suicidal effects of clozapine and lithium have been confirmed but may be less specific than previously thought. Effective pharmacological and psychological treatments of depression are important in prevention as well as education of physicians. There is insufficient evidence regarding possible benefits for suicide prevention of screening in primary care, in public education, and in media guidelines.

Implications of all the available evidence

Implementation of the evidence-supported methods described in this study via appropriate legislation, public and physician education and awareness has the potential to change public health strategies in suicide prevention plans, and significantly reduce the number of deaths due to suicide. More research using RCTs designed with standardised outcome measures and qualitative methods when applicable is needed to investigate public health approaches such as gatekeeper training, media regulation, internet-based intervention, and helplines, as well as in the two health-care approaches of physician education and screening in primary care.

"prevention and control"). "Suicide" was then combined with depression, health education, health promotion, public opinion, mass screening, family physicians, medical education, primary health care, antidepressive drugs, psychotherapy, schools, adolescents, methods, firearms, overdose, poisoning, gas poisoning, and mass media.

Data collection

RB and CBL reviewed abstracts and retrieved full-text articles that met inclusion criteria. Studies were selected if they reported primary outcomes of interest (completed or attempted suicide, or suicidal ideation), or if they included applicable, intermediate outcomes such as help-seeking behaviour or identification of at-risk individuals. The full text of these papers was retrieved and divided into subcategories of suicide prevention as reported in the medical literature: means restriction; treatment interventions including pharmacotherapy; psychotherapy; community and family-based interventions; follow-up and chain-of-care; education and awareness; media, telephone, or internet-based interventions; screening; and combined prevention interventions. Thereafter, all articles were sent to 18 suicide experts (the authors of this report) divided into eight review working groups. To ensure that key references were included in the review process, the identified references were sent to other known senior researchers in the field who were asked to suggest additional references. A face-to-face consensus meeting was held in Leiden, Netherlands, on Feb 12–14, 2015, at which all reports were categorised for their level of evidence according to the Oxford criteria.[14] We excluded some manuscripts because of irrelevance or very low evidence. The results and conclusions of the review were agreed by all authors. In total, four face-to-face meetings between the authors were organised to finalise the results and conclusions.

Role of funding source

The Expert Platform on Mental Health, Focus on Depression, and the European College of Neuropsychopharmacology supported this project (transportation and accommodation for meetings, English editing, and support for two research assistants) but had no influence on the contents of this report. The authors of this report had full access to all data in the study.

Results

Our literature search identified 1797 papers. Another 24 were obtained from other sources (figure). 224 papers were selected because they reported primary outcomes of interest or included applicable intermediate outcomes. These papers were assessed for eligibility, and 80 were excluded because of irrelevance or low evidence.

Heterogeneity in study methodology and in populations prevented a formal meta-analysis. We therefore present a narrative synthesis of the results in key domains of suicide prevention strategies.

30 studies addressed suicide prevention by means restriction (table 1). 14 (47%) of these 30 studies examined firearms, a common suicide method in countries where they are readily available. Availability in households increases risk of firearm suicides with pooled odds ratio (OR) of 3·24 (95% CI 2·41–4·40).[18,19,28] Mann and colleagues[13] concluded that firearm control legislation was associated with reduced suicides; however, more recent findings from the USA show mixed results, indicating that evidence was insufficient to determine the effectiveness of new laws, either alone or in

combination.[15,20] Single studies investigating different populations in the USA, such as general versus high-risk,[16] or severely mentally ill populations,[17] as well as a combination of laws applied together,[21] showed positive effects. Studies on the restriction of firearm availability in other countries also produced mixed results, with some reporting reduced firearm suicide incidence in men aged 20–40 years (Norway,[22] Switzerland,[23] Israel[24]) and in men and women of varying ages (New Zealand,[25] Austria[26]), but usually without a major decrease in overall suicide rates or, alternatively, with just a modest method-substitution effect.[23] Studies in Australia failed to show an association between legislation and suicide in men[19] or people aged 20–40 years,[27] a general decline in this method of suicide having begun before the legislation (but possibly following earlier firearm legislation).

Mann and colleagues[13] identified changes to packaging of analgesics in the UK as beneficial in reducing deaths by suicide. Three studies in the UK have reinforced the evidence of the beneficial effects of smaller packets[29–31] and three studies supported the effectiveness of withdrawing particularly toxic analgesics.[45–47] The estimated reduction in number of deaths was 17 (95% CI −25 to −9) every 3 months in the post-intervention period and the overall reduction in number of deaths was about 43% (specific data not available) in the post-legislation period, after lowering the number of analgesic pills per pack.[29]

Restrictions on the availability of pesticides contribute to reduced suicides in countries where this method of suicide is prevalent.[13] The withdrawal of more toxic pesticides,[32] restriction of access to these pesticides,[33] and measures related to decreasing absorption of toxic substances[34] are likely to reduce suicide in such countries. Safer storage of pesticides is another promising approach to suicide prevention in Sri Lanka[35] and India[36] but evidence is scarce. Little evidence is available on the prevention of hanging, except in psychiatric hospital inpatient units.[37] Potential initiatives have been proposed, such as anti-suicide shower heads in psychiatric units.[38]

Three studies reported strong evidence that the erection of barriers at sites popular for jumping is useful, with an overall reduction in deaths by jumping of 86% (95% CI 79–91) and with little evidence of major substitution to other potential jumping sites.[39–41]

Mann and colleagues[13] concluded that the detoxification of domestic gas and the introduction of catalytic converters in cars were effective prevention methods. We found only one additional study on restricting the ease of purchase of charcoal, which suggested this approach might reduce suicides by carbon monoxide from charcoal burning.[42]

Restricting prescriptions and sales of barbiturates,[43] and reducing concentration of caffeine tablets[44] decreased suicide incidence.

Since psychiatric disorders are a major risk factor for suicidal behaviour, their pharmacological treatment contributes substantially to the prevention of suicide.[48]

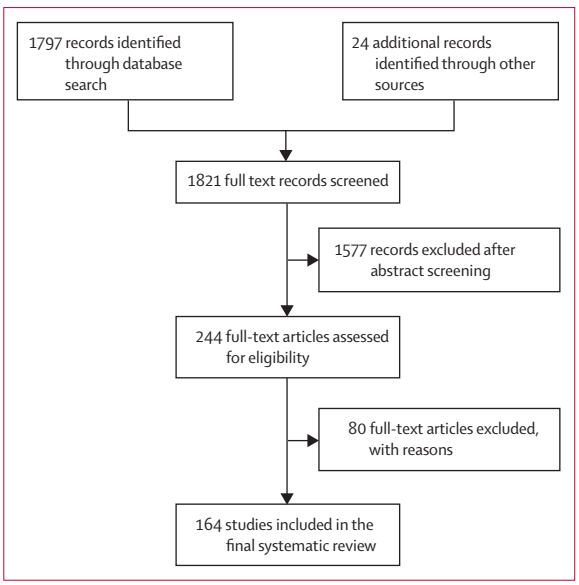

Figure: **PRISMA flow diagram**

Reasonably strong evidence from randomised controlled trials (RCTs) shows that lithium is effective in reducing the risk of suicidal behaviour in people with mood disorders,[49–51] which was supported by the findings of a large-scale naturalistic cohort study[52] comparing lithium with valproate. A specific anti-suicidal effect of lithium was suggested in a population of people who had attempted suicide and who were treated with lithium, compared with people who had attempted suicide and were treated with placebo,[53] although the number of deaths was very small (three deaths *vs* no deaths on lithium). A large-scale naturalistic study[54] suggested that anticonvulsant mood stabilisers might also have protective effects against suicide attempts. Unadjusted rates were greater during treatment with divalproex than during treatment with lithium for suicide attempt that resulted in a visit to the emergency department (31·3 *vs* 10·8 deaths per 1000 person-years, p<0·001), suicide attempt resulting in hospitalisation (10·5 *vs* 4·2 suicide attempts per 1000 person-years, p<0·001), and suicide death (1·7 *vs* 0·7 per 1000 person-years; p=0·04). Precise p values were not reported. After adjustment for age, sex, health plan, year of diagnosis, comorbid medical and psychiatric conditions, and concomitant use of other psychotropic drugs, risk of suicide death was 2·7 times higher (95% CI 1·1–6·3; p=0·03) during treatment with divalproex than during treatment with lithium. Corresponding hazard ratios for non-fatal attempts were 1·7 (95% CI 1·2–2·3; p=0·002) for attempts resulting in hospital admission and 1·8 (1·4–2·2; P<0·001) for attempts diagnosed in the emergency department.[54,55]

Clozapine is the only drug indicated in the USA for reduction of suicide risk in psychosis. A meta-analysis[56] of the effects of clozapine in comparison with other dopamine and serotonin-receptor antagonists

	Study type	Level of evidence
Firearm restrictions		
General population in USA	Systematic review[15]	2a
Men in USA	Ecological[16]	2a
People with serious mental illness	Systematic review[17]	2a–
General population	Systematic review[18]	2c
General population in Australia	Quasi-experimental[19]	2c
General population in USA	Ecological[20]	2c
General population in USA	Ecological[21]	2c
Men in Norway	Ecological[22]	2c
Adult population in Switzerland	Quasi-experimental[23]	2c
Adolescents in Israel	Quasi-experimental[24]	2c
General population in New Zealand	Quasi-experimental[25]	2c
General population in Austria	Quasi-experimental[26]	2c
Youth in Australia (15–44 years of age)	Ecological[27]	2c
Youth in USA (<20 years of age)	Case-control[28]	3b
Analgesic withdrawal		
General population in UK	Quasi-experimental[29]	2c
General population in UK	Quasi-experimental[30]	2c
General population in UK	Quasi-experimental[31]	2c
Pesticide regulation		
General population in Sri Lanka	Ecological[32]	2c
General population in Taiwan	Ecological[33]	2c
Changes in pesticide content		
General population in Sri Lanka	Quasi-experimental[34]	3b
Pesticide storage		
General population in Sri Lanka	Quasi-experimental[35]	2c
General population in India	Cohort study[36]	2c
Restricting measures on hanging		
Psychiatric inpatients	Ecological[37]	2c
General population and population in prison and in psychiatric settings	Systematic review[38]	5
Erection of barriers at jumping hot-spots		
General population in New Zealand, UK, USA, Switzerland, and Canada	Meta-analysis[39]	2a
General population in Canada	Quasi-experimental[40]	2c
General population in Australia	Quasi-experimental[41]	2c
Restricting access to charcoal		
General population in Hong Kong	Quasi-experimental[42]	2c
Restrictions on barbiturate sales		
General population in Denmark	Ecological[43]	2c
Restrictions on caffeine tablet sales		
General population in Sweden	Quasi-experimental[44]	2c

Oxford criteria from the Oxford Centre for Evidence-based Medicine (March, 2009).[14]

Table 1: **Level of evidence (Oxford criteria) of suicide prevention by means restriction**

(eg, olanzapine and risperidone) demonstrated anti-suicidal effect in schizophrenia.[56] However, in another meta-analysis,[57] quetiapine showed no specific effect compared with other dopamine antagonists on the occurrence of suicide and attempted suicide.

Large-scale ecological studies[58–60] of antidepressants indicate that initiation of pharmacotherapy is not associated with an increased risk of suicide, while continuation of pharmacotherapy for depression is associated with a reduced risk of suicide. SSRIs might increase suicidal thoughts, but not actual suicidal behaviour, in early-phase pharmacotherapy of depression in adults.[61] However, emergence of suicidal ideation is low, and the risk–benefit ratio for pharmacotherapy for depression appears to favour its use.[62,63] In depression, the administration of sertraline is associated with decreased suicidal ideation and behaviour but not with emergent suicidal thinking or behaviour.[64] People aged over 75 years, with depression treated with antidepressants might be at reduced risk of attempting suicide.[65] The results of one RCT suggest that SSRIs might exert a stronger effect than would norepinephrine-dopamine reuptake inhibitors on reduction of suicidal thoughts during the initial weeks of pharmacotherapy in high-risk patients with depression.[66] Ecological studies do not show increased sales of antidepressants to be associated with an increase in suicide rates.[67–70] It remains unclear whether drugs for depression decrease or increase suicidal risk in patients with bipolar disorder.[71] However, an evaluation of the relationship between changes in the prescription of antidepressants and changes in suicide prevalence found a clear inverse correlation in 29 European countries.[72]

In children and adolescents with depression, evidence does not support avoidance of use of antidepressant medication because of increased risk of suicidal behaviour, although there is evidence to suggest an increased risk of suicidal ideation in this population.[73] Adding cognitive behavioural therapy (CBT) to fluoxetine might lead to less suicidal ideation and behaviour than treatment with fluoxetine alone.[73]

Ketamine shows promising results as a potentially effective and rapid treatment of suicidal thoughts, independent of improvement in depression, and with minimal side-effects,[74] but effects on suicide attempts or death by suicide have not yet been shown, and effects on suicidal ideation longer than a few days have not been demonstrated. Electroconvulsive therapy was shown to rapidly reduce suicide risk in case series,[75,76] but no controlled trials have been done.

In Mann and colleagues' review,[13] CBT, dialectical behavioural therapy (DBT), problem-solving therapy, and intensive outpatient care with outreach were considered to be promising psychotherapies in suicide prevention; however, they had received insufficient support from RCTs or meta-analyses. Table 2 summarises the level of evidence in studies that investigated various treatment strategies.[48–124] Eight studies reported that, compared with treatment-as-usual or minimal treatment, cognitive therapies such as CBT and manual-assisted cognitive therapy are effective in reducing suicidal ideation and behaviour in adolescents,[86,126] adults (with mixed results),[78,84] and patients with schizophrenia,[80,87] as well as in patients with borderline personality disorder.[81,85] Effects have mostly been found over medium-term follow-up.[84] DBT can reduce suicidal ideation and behaviour in adolescents[79]

and women with borderline personality disorder.[82,83] Preliminary trials have shown effectiveness of low-cost alternatives to classical DBT,[90,91] as well as their acceptability for treatment for non-help-seeking suicidal patients.[92] Group therapy with elements of CBT, DBT, and problem-solving therapy was effective in reducing self-harm for adolescents in one study[79] but showed a negative effect in another.[127] Specific elements for which evidence is weak or absent include skill development,[83] the creation of a so-called own reasons to live list,[88] and the use of modelling in skill development.[128] A multi-systemic therapy approach that addresses improving parenting skills, community, school and peer support, and engagement in pro-social activities was associated with a reduction of suicidal attempts when compared with hospitalisation in adolescents.[128] A variety of other treatments have shown effectiveness in reducing suicidality,[89,93,95] although the level of evidence was relatively low. Psychosocial treatments have not shown clear effectiveness in reducing deaths by suicide, perhaps because of small sample sizes.[78] Community, family, and group-based interventions were not identified by Mann and colleagues.[13] We found two meta-analyses[96,97] that did not show community mental-health services for people with serious mental illness to be superior to standard management in preventing suicide. However, results of one study[97] showed greater acceptance of treatment, and proposed the possibility of reduced hospital admissions and suicide deaths. A meta-analysis conducted in Japan[100] showed a reduction in suicides among people aged over 75 years following a community-based intervention with screening and follow-up components based on pre-implementation versus post-implementation changes, but with no comparative condition.

Other studies assessing social support strategies in different populations and settings showed inconsistent effects on suicide attempts and ideation,[98,99,101,102] but positive effects on depressive symptoms.[101,102] One systematic review[103] of family-based interventions for patients with schizophrenia found no effect on suicide. RCTs evaluating family-based interventions in suicidal adolescents have consistently shown a clear decrease in suicidal ideation and suicide risk factors,[104–106] and enhanced protective factors[105] compared with routine care. Finally, a brief family-based crisis intervention with suicidal adolescents in emergency room settings showed reduced psychiatric hospitalisations and suicide attempts at 3 months of follow-up.[107] Table 3 summarises the level of evidence in studies that investigated population-level prevention strategies.[121–188]

Mann and colleagues[13] reported mixed results on the efficacy of follow-up for people who attempt suicide. Since their report, several more studies have showed conflicting results. Contact interventions through sending regular postcards appeared to be effective in reducing repetition of suicidal behaviour in Iran, but not in high-income countries.[112,113] Provision of information and support through telephone or face-to-face contacts appeared to reduce suicides in low-income and middle-income countries, where mental health resources in the community are scarce, but paradoxically did not affect repetition of attempted suicide.[108,109,111] Structured follow-up of people who attempt suicide decreased the

	Level of evidence	Study type
Lithium		
Unipolar and bipolar patients	1a	Meta-analysis[49]
Patients with major affective disorder	1a	Meta-analysis[50]
Patients with major affective disorder	1b	RCT[53]
General population in Denmark	2b	Cohort study[51]
Lithium and valporic acid		
Patients with bipolar disorder, with a previous suicide attempt	1b	RCT[55]
Antiepileptics* and lithium		
Patients with bipolar disorder	2b	Cohort study (retrospective)[54]
Clozapine		
Patients with schizophrenia	1a	Meta-analysis[56]
Quetiapine and typical antipsychotics*		
Patients with schizophrenia	1a	Systematic review[57]
Antidepressants*		
Patients prescribed antidepressants	2c	Ecological[58]
Patients prescribed antidepressants	2c	Ecological[59]
Patients with major depressive disorder, prescribed antidepressants	2c	Cohort study (prospective)[60]
Patients with major depressive disorder, with past suicide attempt	2b	Cohort study[62]
Patients prescribed antidepressants	2c	Ecological[68]
General population in Sweden	2c	Ecological[69]
General population in Austria	2c	Ecological[70]
General population in Europe	2c	Ecological[72]
Patients prescribed antidepressants	3a	Systematic review[77]
Bipolar patients	3a	Systematic review[71]
Ketamine		
Suicidal patients	1a–	Systematic review[74]
SSRIs		
Patients with major depressive disorder taking SSRIs	1a	Meta-review of systematic reviews[61]
Patients with major depressive disorder	1b	RCT[66]
Elderly patients with major depressive disorder, with past suicide attempt	3b	Case-control (retrospective)[65]
SSRI (citalopram)		
Patients with schizophrenia and schizoaffective patients	1b	RCT[63]
SSRI (sertraline)		
Elderly patients with major depressive disorder	1b	RCT[64]
SSRI (fluoxetine)		
Adolescents with major depressive disorder	1b	RCT[73]
Electroconvulsive therapy		
Patients with major depressive disorder	2b	Cohort study[75]
Psychiatric inpatients	3b	Quasi-experimental[76]
Psychosocial interventions		
Patients with history of self-harm	1a	Meta-analysis[78]

(Table 2 continues on next page)

	Level of evidence	Study type
(Continued from previous page)		
Group therapy		
Adolescents with history of self-harm	1a–	Systematic review[79]
Adolescent psychiatric inpatients	3b	Quasi-experimental (retrospective open label)[88]
Prisoners with borderline personality disorder	4	Quasi-experimental[93]
Cognitive behavioural therapy		
Patients with schizophrenia	1b	RCT[80]
Patients with suicidal behaviour	2a	Meta-analysis[84]
Cognitive psychotherapy		
Patients with borderline personality disorder	1b	RCT[81]
Patients with schizophrenia	3a	Systematic review[87]
Patients with borderline personality disorder	2b	RCT[85]
Dialectical behavioural therapy		
Patients with borderline personality disorder	1b	RCT[82]
Patients with borderline personality disorder	1b	RCT[83]
Patients with borderline personality disorder	4	Quasi-experimental[90]
Psychosocial interventions in clinical settings		
Suicidal adolescent and adult patients	2b	Systematic review[86]
Respite centre		
People in a suicidal crisis	3b	Quasi-experimental[89]
Group dialectical behavioural therapy		
Patients with borderline personality disorder	4	Quasi-experimental[91]
Dialectical behavioural therapy (single meeting)		
Suicidal patients	4	Quasi-experimental[92]
Integrative psychotherapy		
People with suicidal ideation	4	Quasi-experimental (retrospective controlled study)[94]
Psychodynamic therapy		
Adult outpatients	4	Cohort study[95]
Intensive community-based case management		
Patients with severe mental disease	1a	Meta-analysis[96]
Community-based intervention		
Patients with severe mental disease	1a–	Meta-analysis[97]
Parental involvement in therapy		
Adolescent psychiatric patients	1b	RCT[98]
Adolescent psychiatric patients	1b	RCT[99]
Community-based screening and follow-up		
Elderly population in Japan	2a	Meta-analysis[100]
Culturally informed community-based treatment		
African American women attempting suicide	2b	RCT[101]
Group intervention (hiking)		
People attempting suicide	2b	RCT[102]
Family-based intervention		
Patients with schizophrenia	1a	Meta-analysis[103]
Suicidal adolescents	1b	RCT[104]
Brief parent-adolescent intervention		
Parents of suicidal adolescents	1b	RCT[105]
Brief psycho-education to parents		
Parents of suicidal adolescents	1b	RCT[106]
Family crisis intervention		
Suicidal adolescents	2b	Quasi-experimental[107]

(Table 2 continues on next page)

number of repeated attempts[110,114] and suicides[108,115] in some but not all studies.[116,117] Collaborative care with the involvement of primary health-care services in follow-up has been shown to be feasible, acceptable, and effective (in terms of ideation) compared with standard care.[118,122,124] Positive results were identified in similar programmes targeting depressed and suicidal elderly patients.[119–121] Finally, a cohort study[190] showed that where mental health services are available, especially with a combination of resources, suicidal behaviour was clearly reduced. On the other hand, no significant association was found between physician density and suicide rates.[123]

Mann and colleagues[13] concluded that few school-based programmes were evidence based or had been assessed in terms of the effectiveness in preventing suicidal behaviour. Over the past decade, evaluation studies involving school-based programmes have been of better quality. Systematic reviews,[132–136] although including few RCTs, consistently indicate improved knowledge and attitudes towards suicide but no effect on actual suicidal behaviour. However, three large RCTs[129–131] emphasising mental health literacy, suicide risk awareness, and skills training in schools, showed significant effects on suicide attempts and ideation. At 12 month follow-up, there was a significant reduction in suicide attempts (OR 0·45, 95% CI 0·24–0·85; p=0·014) and severe suicidal ideation (0·50, 0·27–0·92; p=0·025), compared with the control group.[130] Prospective cohort studies[137,139,191] assessing awareness programmes in schools showed inconsistent outcomes linked to suicidal behaviour. The level of evidence was 2c with one study showing positive,[137] one showing negative,[138] and one showing mixed outcomes.[139]

Ecological studies have linked initiation of general public awareness campaigns to a significant increase in calls to helplines[140–142] but without reduction in suicides.[140] One study[143] showed reduced suicidal ideation and plans in a specific population of gay men, and another[144] showed reduction in suicides at short-term follow-up.

Education of primary care physicians targeting depression recognition and treatment was identified as one of the most effective interventions in lowering suicide rates.[13] Since 2005, ecological studies in Sweden,[145] Hungary,[146] and Slovenia,[147] investigating programmes for general practitioners (GPs) have shown a significant increase in antidepressant use and decreased suicide rates.[145,146] In a multi-component intervention,[146] the effectiveness of educational elements could not be separated from other elements of the intervention (free telephone consultations with local psychiatrists, a new depression clinic, and access to cheaper antidepressants). Since 2005, there have been no RCTs on this subject, but results in the former systematic review[13] consistently showed the benefit of the GPs' educational activities.

Mann and colleagues[13] reported that gatekeeper training was helpful in reducing the number of suicides,

provided that formalised roles and pathways to treatment were readily available.[13] Since 2005, gatekeeper training has been studied in several populations, including military personnel,[153] public school staff,[148] peer helpers,[149] youth workers,[152] clinicians,[145,146,156] depressed persons,[154] and Indigenous people.[155] However, no RCT has shown that gatekeeper training alone affects suicide rates. Systematic reviews of studies in various populations,[150] as well as in Indigenous people in Australia, the USA, Canada, and New Zealand,[151] mostly showed positive effects on knowledge, skills, and attitudes of trainees. In some of the studies from New Zealand, a decrease in suicide or suicidal behaviour was reported, but they lacked control groups.[151]

Two systematic reviews[157,158] have shown an association between the media depiction of suicide and actual suicidal behaviour, although the methodological quality of the studies reviewed was limited. The effects seem to be bi-directional: detrimental in vulnerable populations, such as people who attempt suicide,[161] but protective in the general population when emphasising positive coping.[160] Media blackouts or better reporting quality have been associated with decreased suicidal behaviour.[159,160] Media participation in the development of guidelines assists in successful implementation, but the effectiveness of such guidelines in mitigating imitative suicides varies considerably.[157]

Studies of telephone and internet services usually have relatively low levels of evidence. These studies have mainly focused on outcome measures such as acceptability of services by users,[178] identification of people at risk and referral to help services,[179] and compliance with referrals.[180] Other studies have identified specific effective characteristics in these interventions[174,181] and service providers,[183] as well as service-use barriers.[182] Some report reduction in suicidal ideation following interventions such as a brief mobile treatment intervention in Sri Lanka,[173] unguided online self-help,[175] and a telephone aftercare intervention.[176] Intervention is more efficient than wait-listing.[177]

Mann and colleagues[13] identified the need for assessment of the cost-effectiveness of screening in the general population versus identified at-risk populations in reduction of suicide, the predictive validity and reliability of specific screening tools, and the assessment of standard screening across different cultures. A large systematic review[162] concluded that evidence was insufficient to determine the benefits of screening in primary care populations. Eight other studies assessed the screening of a total of 15 244 cases and controls.[163,165,166,168–172] One RCT[163] showed no iatrogenic effects in youth suicide screening or in high-risk populations. A systematic review[167] showed that youth suicide screening programmes improved identification in adolescents at risk; however, the positive predictive value of subsequent suicidal behaviour in school settings was relatively low in some of these reports (range 6–33%).

	Level of evidence	Study type
(Continued from previous page)		
Brief intervention in emergency room and follow-up contact		
People attempting suicide	1b	RCT[108]
People attempting suicide	1b	RCT[109]
Integrative programme (outreach, problem solving, adherence, continuity)		
People attempting suicide	1b	RCT[110]
Postcard intervention		
People with past self-poisoning	1b	RCT[111]
Adolescents and adults with repeated self-harm	1b	RCT[112]
Adolescents with suicide risk	2b	RCT[113]
Follow-up meeting		
Patients with self-harm	2b	Cohort study[114]
Aftercare programme		
People attempting suicide (>15 years of age)	2b	Cohort study[115]
Assertive outreach intervention		
People attempting suicide (>12 years of age)	2b	RCT[116]
Chain of care intervention		
People attempting suicide	2b	Cohort study[117]
Next-day appointment		
Adult suicidal patients	2b	RCT[118]
Collaborative prevention in primary care		
Elderly patients with major depressive disorder	2b	RCT[119]
Elderly patients with major depressive disorder and dysthymic patients	2b	RCT[120]
Management of depression in primary care		
Elderly patients with major depressive disorder	2b	RCT[121]
Availability of safety-net of mental health services		
Suicide attempters	2c	Ecological[122]
Physician density		
Adolescents and young adults	2c	Ecological[123]
Collaborative assessment and management		
Adult suicidal patients	4	Cohort study[124]

Oxford criteria from the Oxford Centre for Evidence-based Medicine (March 2009)[14] *The general terms antidepressants, antiepileptics, or antipsychotics were used only when the study assessed heterogeneous groups and the neuroscience-based nomenclature[125] could not be used. RCT=randomised controlled trial.

Table 2: **Level of evidence (Oxford criteria) of suicide prevention strategies by treatment interventions**

Screening in both school[168] and primary-care settings[169] was found to be effective and safe[163] in enhancing treatment referrals and service use in high-risk adolescents at long-term follow-up. A large RCT of suicide prevention programmes implemented in Europe[189] did not show significant effects of screening in reducing suicidal ideation and attempts.[130] However, screening for risk behaviours in addition to psychopathology was shown to add significant value in identifying European pupils with mental health problems.[164] In people aged over 75 years in Japan, the use of depression screening and psychiatrist follow-up lowered suicide prevalence by 61%.[171]

Some publications since 2005 have addressed the effect of combination and multi-level prevention programmes on suicide and suicide attempts (appendix).

See Online for appendix

	Level of evidence	Level of evidence
School-based programmes		
Adolescents	1b	RCT[129]
Adolescents	1b	RCT[130]
Children	1b	RCT[131]
Young adults (students)	2a	Meta-analysis[132]
Adolescent	2a	Systematic review[133]
Children and adolescents	2a	Systematic review[134]
Adolescents	2a	Systematic review[135]
Adolescents	2a	Systematic review[136]
Adolescents	2b	Quasi-experimental[137]
Adolescents and adults (school staff)	2b	Quasi-experimental[138]
Adolescents	2b	Cohort study[139]
Public awareness campaigns		
Adult men in Austria	2c	Quasi-experimental[140]
General population in USA	2c	Quasi-experimental[141]
General population in USA	2c	Ecological[142]
Gay men in Switzerland	2c	Quasi-experimental[143]
General population in Japan	2c	Ecological[144]
Primary care physicians education		
Primary care physicians in Sweden	2c	Quasi-experimental[145]
Primary care physicians in Hungary	2c	Quasi-experimental[146]
Primary care physicians in Slovenia	2c	Quasi-experimental[147]
Gatekeeper training		
School staff	1b	RCT[148]
Suicidal callers (to crisis line)	1b	RCT[149]
Mixed populations	2a	Systematic review[150]
Indigenous peoples in Australia, USA, Canada, and New Zealand	2a	Systematic review[151]
Youth helpers in schools	2b	Quasi-experimental[152]
Counselling staff for veterans in USA	2b	Cohort study[153]
Adolescents and adults with major depressive disorder	2c	Cohort study[154]
Native children and adolescents in Alaska	2c	Ecological[155]
General population in Nuremberg	2c	Quasi-experimental[156]
Media reporting		
Media reporting	2a	Systematic review[157]
Mixed populations	2a	Systematic review[158]
General population in Austria	2c	Ecological[160]
Depressed outpatients in Taiwan	4	Quasi-experimental[161]
Media blackout		
General population in Austria	2c	Quasi-experimental[159]
Screening		
Primary care patients	1a–	Systematic review[162]
Adolescents	1b	RCT[163]
Adolescents	1b	RCT[164]
Adolescents	1b	Quasi-experimental study[165]
Helpline callers	1b	Cohort study[166]
Adolescents	2a	Systematic review[167]
Adolescents	2b	Cohort study (longitudinal)[168]

(Table 3 continues on next page)

Discussion

The heterogeneity of strategies and outcome measures, as well as absence of good standards for evidence level in the literature, limits conclusions about the current effectiveness of suicide prevention strategies. However, there have clearly been major advances since the review by Mann and colleagues in 2005.[13]

There is now strong evidence that restricting access to lethal means is associated with a decrease in suicide and that substitution to other methods appears to be limited. This is clearly a major strategy to be integrated in national suicide prevention plans.

Data support the use of a few pharmacological interventions in suicide prevention. First, antidepressant pharmacotherapy treatment in adults is associated with reduced suicide risk, while initiation of pharmacotherapy does not lead to an exacerbation of suicide risk. In people aged over 75 years with depression, there is a clear beneficial effect of pharmacotherapy on the risk of attempted and completed suicide. In children and adolescents, increased risk of suicidal thoughts has to be taken into account when starting pharmacotherapy for depression. However, given the increased risk of suicide in untreated depression and the absence of an increased risk of suicide associated with pharmacotherapy, currently available evidence does not support the avoidance of initiation and continuation of pharmacotherapy for depression in children and adolescents. Therefore, the ongoing discussion about possible induction of suicidality in minors should not prevent physicians from prescribing SSRIs.[77] If a decision is made to use medication, then fluoxetine might be considered, given that it is recommended as first-line medication in guidelines. Second, lithium is effective in reducing the risk of suicide in people with mood disorders, possibly through decreasing aggression and impulsivity. Valproate might have similar efficacy in patients with bipolar disorder. Third, an anti-suicidal effect of clozapine in psychosis has been demonstrated; however, recent studies suggest that clozapine might not differ from risperidone or olanzapine in this respect. Studies of ketamine suggest promising rapid beneficial effects on reducing suicidal thoughts.

Case series show that electroconvulsive therapy provides a rapid relief of suicidal thoughts. Electroconvulsive therapy should therefore be considered earlier, rather than at its conventional last resort position for patients at risk.

Data support the efficacy of psychotherapies such as CBT and DBT. Psychodynamic psychotherapies have not been systematically studied. Understanding which treatment components (such as the development of a therapeutic alliance, the role of case-management and of significant others) might be effective in treatment of suicidality is an important line for future investigation.

The evidence on chain of care and follow-up is scarce and heterogeneous, leading to weak significance of the aggregate data. Follow-up of people who attempt suicide

is strongly supported by data and should be included in any national suicide prevention strategy. Findings that associate mental health service availability and reduced rates of suicide indicate the need for providing mental health services in national prevention initiatives.

Community and family-based interventions are not effective in preventing suicide in severely ill mental patients. Nevertheless, the ability of such interventions to promote treatment acceptance and to reduce hospitalisation and suicide should be noted. Although cross-cultural replication is needed, there is evidence that in elderly people, screening for depression combined with community follow-up is effective in reducing suicide risk. Family interventions with suicidal adolescents show a promising effect on suicide ideation.

RCTs increasingly show reduced suicide attempts and ideation following school-based mental health and suicide awareness programmes, with or without combined screening. While there has been an increase in the evaluation of general public awareness campaigns, a lack of RCTs remains a major limitation, indicating that no statements can be made about the effectiveness of these campaigns in reducing suicide.

Interventions including training programmes for GPs might be followed by increased prescription of antidepressants, and subsequent decrease in suicides, but a direct association between training and reduced rates is difficult to identify. Future research using RCTs should examine the value of GP training and the efficiency of their diagnostic capabilities.

No RCT showed that gatekeeper training alone affected suicide rates. Gatekeeper training is usually implemented along with other initiatives, making it difficult to identify the effect of this specific intervention on suicide rates. Intermediate outcome measures, such as referral rates and psychiatric treatment rates, should also be used.[13] Future research should review elements of training, such as who is best to lead it, to whom it should be delivered, and with which specific content. Evaluation of the uptake of training in different specific contexts or populations is especially needed.

Although no controlled studies were done on the effect of media on suicidal behaviour over the last decade, a clear bidirectional effect can be established. Media should be used in collaboration with journalists as a channel for appropriate public education. Further investigation is needed on the effect of the internet and social media on suicidal behaviour.

Thus far, the evidence of telephone and internet intervention effectiveness is rather scarce and of low quality. Rapidly increasing utilisation of information and communication technologies in suicide prevention requires research assessing their efficacy.

There is insufficient evidence of the benefits of screening in primary care populations for reducing risk of suicide. If referral to treatment is the outcome measure and not suicidal behaviour, screening might be more effective, provided that the chain of care is continuous and useful. Even in high-risk populations, evidence does not justify the cost of expensive screening procedures.

Combinations of evidence-based strategies should be assessed on the individual and population levels using RCTs with sufficient power and similar methodologies. Future research on the efficacy of combined evidenced-based prevention strategies should focus on specific targeted populations (psychiatric patients, children and adolescents, older people, and ethnic minorities), as well as on cost-effectiveness and effect size. Data suggest that each specific risk group might need a tailored preventive approach. Priority should be given to reaching out to those who fail to seek medical or psychological help, with particular attention paid to older subjects.

The main limitation of this study is that the final decisions on the level of evidence rely on the investigators' judgments and therefore reproducibility of

	Level of evidence	Study type
(Continued from previous page)		
Adolescents	2b	Ecological[169]
Adult psychiatric outpatients	2c	Quasi-experimental[170]
Elderly population in Japan;	2c	Quasi-experimental[171]
Adolescents	4	Cohort study[172]
Mobile phone intervention		
People attempting suicide	1b	RCT[173]
Telephone/internet-based intervention		
Crisis line callers/internet chat and forum users	2b	Cohort study[174]
Internet-based intervention		
Suicidal adults	2b	RCT[175]
Telephone intervention		
Adolescent outpatients (alcohol abusers)	2b	RCT[176]
Crisis line callers	2b	RCT[177]
Mobile phone intervention		
Suicide attempters	4	Cohort study[178]
Telephone intervention		
Suicide attempters (veterans)	4	Cohort study[179]
Adult crisis-line callers	4	Cohort study[180]
Crisis line callers	4	Cohort study[181]
Crisis line callers	4	Cohort study[182]
Crisis line callers	5	Cohort study[183]
Combined interventions		
Elderly population in Japan	2b	Quasi-experimental[184]
Elderly population in Japan	2b	Quasi-experimental[185]
General population in Hungary	2c	Ecological[186]
General population in Germany	2c	Quasi-experimental[187]
General population in Germany	2c	Quasi-experimental[188]

Oxford criteria from the Oxford Centre for Evidence-based Medicine (March 2009).[14] RCT=randomised controlled trial.

Table 3: **Level of evidence (Oxford criteria) of suicide prevention using population-level prevention strategies**

the findings might be more difficult than in a formal meta-analysis. However, 18 investigators participated in this process, and decisions on disagreements were made based on consensus. There is also an inherent risk of bias at review (eg, incomplete retrieval of identified research, reporting bias). Finally, the literature review goes only to the end of 2014.

To conclude, sufficient evidence supports effective methods of prevention of suicidal behaviour. Potential interventions using new social media, mobile technologies, and continuous monitoring of large datasets seem to be the next field to explore in the coming decade. It is difficult to standardise methods for evaluation of suicide prevention initiatives. However, wherever possible, randomised trials should be the gold-standard approach. It is also important to look for unexpected untoward effects of initiatives, such as encouragement of suicidal behaviour by greater media attention, or method substitution where access to a common method of suicide is restricted. Evaluative research should be integral to national suicide prevention plans, including access to adequate funding to encourage and permit the necessary studies. Because suicide is a major cause of death and disability, the implementation of proven, evidence-based, and cost-effective strategies are the duty and responsibility of public health policy makers and health-care providers.

Contributors

GZ and JZ conceived the idea and designed the study. GZ drafted the first version. All authors participated in data analysis, review process, and preparation of the final version.

Declaration of interests

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