

## REVIEW ARTICLE

Allan H. Ropper, M.D., *Editor*

## Suicide

Seena Fazel, M.D., and Bo Runeson, M.D., Ph.D.

From the Department of Psychiatry, Warneford Hospital, University of Oxford, Oxford, United Kingdom (S.F.); and the Department of Clinical Neuroscience, Karolinska Institutet, Stockholm (B.R.). Address reprint requests to Dr. Fazel at the Department of Psychiatry, Warneford Hospital, University of Oxford, Oxford OX3 7JX, United Kingdom, or at [seena.fazel@psych.ox.ac.uk](mailto:seena.fazel@psych.ox.ac.uk).

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**T**HROUGHOUT THE WORLD, APPROXIMATELY 800,000 PEOPLE DIE BY suicide every year, accounting for 1.5% of all deaths.<sup>1</sup> Suicide is the 10th leading cause of death in North America and the foremost cause of death worldwide among persons 15 to 24 years of age.

## EPIDEMIOLOGY

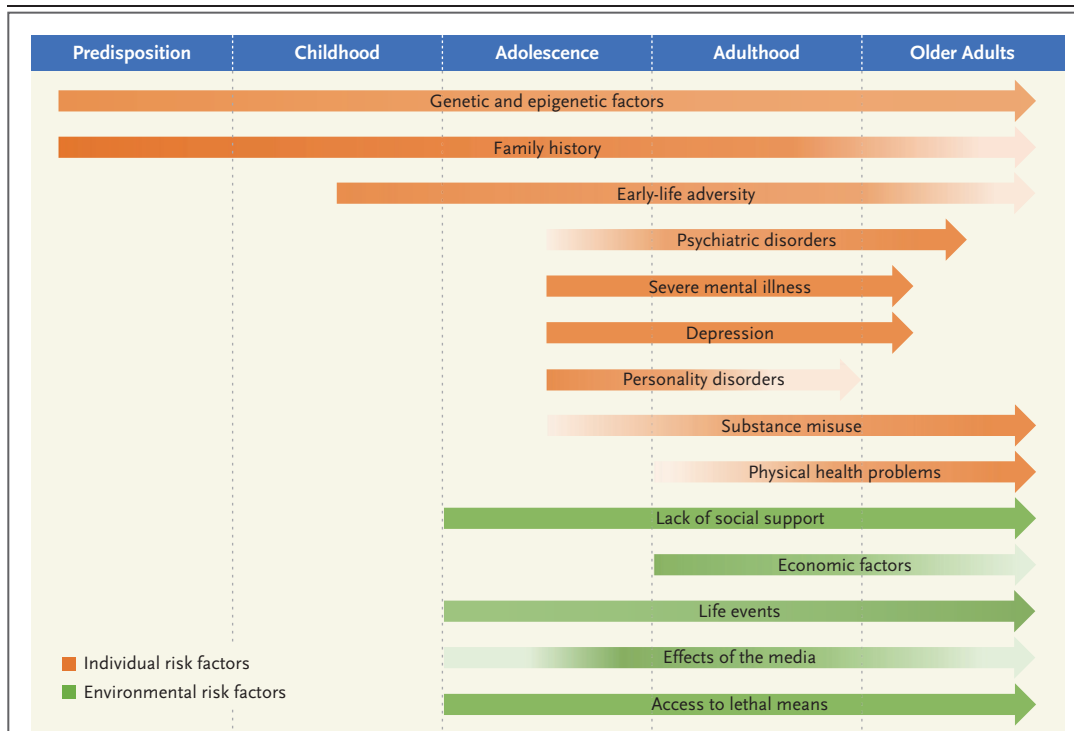
The World Health Organization (WHO) estimated that the 2016 suicide rate was 10.6 suicides per 100,000 persons, with 80% of suicides occurring in low- and middle-income countries.<sup>2</sup> Across the six WHO regions, the incidence of suicide differed by a factor of 4 between the region with the highest rate (Europe) and the region with the lowest rate (the Eastern Mediterranean, including the Middle East). Explanations for this variation include differences in the classification of suicide, sociocultural attitudes toward suicide, access to lethal means of dying by suicide, and the adequacy of treatment for mental disorders. Worldwide, suicide rates vary according to age and sex, with the highest rates among older people and with higher rates among men (15.6 suicides per 100,000) than among women (7.0 per 100,000).<sup>2</sup> Suicide rates have been declining over recent decades in most of these regions, with an estimated 18% reduction from 2000 to 2016. The exception is the Americas; in the United States, rates have increased by 1.5% annually since 2000,<sup>3</sup> and rates among men 45 to 64 years of age increased from 21 suicides per 100,000 in 1999 to 30 per 100,000 in 2017.<sup>4</sup>

Ecologic studies, which can explain time trends within countries, suggest a contribution of restrictive alcohol policies in lowering suicide rates.<sup>5</sup> Changes in suicide rates have also been attributed to restriction of common means of suicide, such as detoxification of domestic gas (i.e., the reduction and eventual elimination of the carbon monoxide content of gas owing to a switch to natural gas) in the United Kingdom, starting in the 1960s,<sup>6</sup> decreased availability of alcoholic spirits in Russia,<sup>7</sup> and state restrictions of firearms in the United States.<sup>8</sup>

As extrapolated from household surveys, for each suicide death, there are 20 suicide attempts (defined as self-injurious behavior associated with an intent to die), amounting annually to 16 million attempts and approximately 160 million persons who express suicidal thoughts.<sup>9</sup> The epidemiology of self-harm, defined as any type of self-injurious behavior, including suicide attempts and nonsuicidal self-injury, is different from the epidemiology of suicide, with the highest rates of self-harm among women and young people. Among persons who attempt suicide, 1.6% die by suicide within the next 12 months, and 3.9% die by suicide within the next 5 years.<sup>10</sup>

## RISK FACTORS

Risk factors for suicide have been investigated at the population and individual levels; in addition, predisposing factors and precipitating events have been exam-



**Figure 1. Risk Factors for Suicide and the Strength of the Association throughout Life.**  
 The strength of the association between each risk factor and suicide is indicated by the shading (darker shading indicates a stronger association).

ined, mainly at the individual level. Each of these factors can be mediated through genetic, psychological, and personality characteristics, making most explanatory models complex and difficult to interpret. One approach to understanding suicide has been life-course analysis,<sup>11</sup> which is based on the premise that risk factors come into play at different stages of life (Fig. 1) and that suicide is the cumulative result of risk factors over a lifetime.

Individual factors, particularly psychiatric disorders,<sup>12</sup> have the strongest effect on suicide rates in life-course models. Depression, bipolar disorder, schizophrenia-spectrum disorders, substance use disorders, epilepsy,<sup>13</sup> and traumatic brain injury<sup>14</sup> each increases the odds of completed suicide by a factor of more than 3. Other predisposing factors include a previous suicide attempt, childhood sexual abuse, a family history of suicidal behavior, and loss of a parent to suicide in early childhood (Table 1). Causality is inferred by the consistent, strong, and temporal associations of these risk factors with suicide, but randomized, controlled trials of treatment

aimed at modifiable risk factors have been underpowered to examine their effect on suicide. Information collected on persons who have died by suicide (“psychological autopsy”) indicates that mood disorders and substance use disorders are the major risks.<sup>23</sup> In high-income countries, mental illnesses are estimated to be present in half of persons who have died by suicide, with affective disorders (depression and bipolar disorder) involved in a third to half of suicides.<sup>24</sup> Suicide also occurs in the absence of an identifiable psychiatric disorder, and even when present, psychiatric disorders have co-occurred with other predisposing and precipitating risk factors in persons who have died by suicide.

Predisposing factors for suicide are thought to interact with precipitating factors, and predisposing factors may have different effects depending on the resilience of the person. Predisposing and precipitating factors together are considered to result in psychological changes, including feeling alone, hopeless, and burdensome, which lead in turn to social isolation. These psychological changes, combined with

**Table 1. Risk Factors for Suicide.**

Risk Factor	Strength of Association with Suicide	Quality of Evidence*
<b>Precipitating factors</b>		
Drug and alcohol misuse <sup>12</sup>	Strong	High
Access to lethal means <sup>15</sup>	Moderate	High
Life events <sup>16</sup>	Moderate	High
New diagnosis of terminal or chronic physical illness <sup>17</sup>	Moderate	Moderate
Media effects <sup>18</sup>	Weak	Moderate
<b>Predisposing factors</b>		
Neuropsychiatric disorders <sup>12</sup>	Strong	High
Family history of suicidal behavior <sup>19</sup>	Strong	High
Previous suicide attempt <sup>20</sup>	Moderate	High
Adverse childhood experiences <sup>21</sup>	Moderate	Moderate
Socioeconomic deprivation <sup>22</sup>	Weak	Low

\* Low quality indicates reported associations alone, moderate quality indicates reported associations that have been replicated in different settings, and high quality indicates associations that are supported by evidence from quasi-experimental studies or clinical trials.

access to lethal means, can allow for suicidal acts.<sup>25</sup>

Among precipitating factors, stressful life events precede many suicides and suicide attempts (Table 1). Such events include relationship difficulties (particularly separation or divorce), death of a partner, and death by suicide of someone close<sup>16</sup> — in particular, for mothers, death by suicide of adult children.<sup>26</sup> Other precipitating factors include receiving a diagnosis of a chronic medical condition, particularly in the first week after a diagnosis of cancer.<sup>17</sup> Suicide risk is also increased among assault victims, persons who have been arrested, and prisoners.<sup>27</sup>

On a population level, natural disasters can act as triggers for suicide, putatively in a dose–response manner in some instances. Paradoxically, terrorist attacks appear to be temporally protective against suicide in exposed populations. Greater social cohesion may have explained lower suicide rates in the New York metropolitan area in the months after the September 11, 2001, attacks.<sup>28</sup> There is a small increase in suicide rates after the suicide of a celebrity, and the effect is magnified when press guidelines for avoiding both explicit descriptions of the death and speculation about causes are disregarded.<sup>18</sup> The evidence for media influences on adolescents is

weaker than the evidence for media influences on adults.

Social factors, particularly economic adversity, modify the influence of many risk factors for suicide.<sup>22</sup> People in unskilled professions have an increased risk of suicide, which is partly explained by greater psychosocial stress; however, people in professions with access to lethal means for suicide have high rates, such as farmers, nurses, veterinarians, physicians, and police.<sup>29</sup> Religious affiliation of any type has been reported to be protective against suicide, but this has not been shown for minority religious groups, which may be socially isolated.<sup>30</sup>

#### PSYCHOLOGICAL MODELS OF SUICIDE

A stress-diathesis psychological model explains suicide risk as a combination of stressors in vulnerable persons. Individual vulnerability is considered to express itself in suicidal ideation under stress and is magnified by impulsivity and aggression, which increase the likelihood of acting on suicidal ideas.<sup>31</sup> This model has been augmented by an interpersonal psychological model, in which the sense of burdening others and not being accepted in social groups interacts with the feeling of hopelessness that these perceptions will not change. Another aspect of psychological models is the premise that suicidal persons have a reduced fear of death and increased pain tolerance as a result of habituation by previous acts of self-harm.<sup>25</sup>

Impulsivity is a component of most psychological models of suicide. This trait is partly familial<sup>32</sup> and has a disproportionate influence on suicide risk among young people.<sup>33</sup> Perfectionism may be another contributory personality trait, leading to isolation out of fear of being stigmatized for an interpersonal crisis. A perfectionist trait also impedes psychological recovery from self-harm or suicidal ideation.<sup>34</sup> Rigidity, inflexibility, and rumination impair problem-solving with respect to common stressors, including trying to find solutions to financial problems, unemployment, criminal justice involvement, interpersonal conflicts, and family strife.<sup>35</sup>

#### FAMILIAL, GENETIC, AND OTHER BIOLOGIC FACTORS

A family history of suicide is a risk factor for suicide,<sup>19</sup> with some evidence suggesting that a mother's suicidal behavior has a greater influence than a father's suicidal behavior.<sup>36</sup> Furthermore,

the effect of parental suicide is greater on younger children than on adolescents; that is, the younger children are when they experience suicidal behavior in their parents, the higher their lifetime risk of suicide.<sup>37</sup> This familial risk is partially explained by parental mood disorder, traits of impulsivity and aggressiveness, or neurocognitive disorders, all of which are heritable.<sup>38</sup> However, studies have not been able to differentiate between behavioral imitation of a family member's suicide and a genetic propensity for suicide as explanatory factors. Twin studies have yielded estimates of the genetic contribution to the risk of suicidal behavior that range from 30 to 50%.<sup>39</sup> Despite the apparent heritability of suicidal behavior, risk genes have not been identified.<sup>39</sup> Some unreplicated studies have suggested that genetic promoters of inflammation overlap suicide risk and that suicide risk is mediated by immunologic responses to acute infection, but these observations are speculative.

Imaging and postmortem studies have shown changes in serotonergic pathways that are correlated with suicide, but these associations have not been validated. One hypothesis is that changes in the medial prefrontal cortex lead to an overvaluing of social signs of rejection, deficits in emotional responses, and poor decision making.<sup>40</sup> One study showed that persons who experienced adversity in early life have an overactive hypothalamic–pituitary–adrenal axis in response to stress, which increases anxiety and acts as a mediator of suicidal behavior.<sup>41</sup>

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#### ASSESSMENT OF SUICIDE RISK

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Models for predicting suicide risk have been used to improve clinical decision making, assist in the identification of high-risk groups,<sup>42</sup> and translate evidence-based risk factors into improved risk assessment. These models can provide transparency and consistency in decision making about suicide risk. However, models used in clinical practice vary in content and in the degree of validation and often have been developed for other purposes, such as assessing patients for depression or rating the severity of current suicidal ideation rather than predicting the future risk of suicide (Table 2). Risk models for suicide have been used in emergency departments to assess persons who have harmed themselves, but these models have a poor balance

between sensitivity and specificity and do not provide probability scores.<sup>48</sup> Thus, these assessment tools may increase the clinical workload by requiring psychiatric assessment or hospitalization in cases of false positive risks of suicide. In the case of some of these tools, most of the patients who ultimately died by suicide were predicted to be at low risk. Nevertheless, structured tools can provide a baseline assessment during initial contact with health care providers, offer a checklist to identify risk factors, and lead to interventions for those persons who are predicted to be at high risk for suicide.<sup>49,50</sup> An advantage of empirically derived prediction models over subjective clinical judgment is that they attempt to incorporate the relative strength of risk factors and their interactions. The alternative to these instruments is unstructured clinical approaches, in which clinical impressions are derived about suicide risk. Some studies have shown that these unstructured approaches may be more inaccurate and subject to a range of cognitive biases on the part of the assessor, including an overemphasis on predisposing factors<sup>51</sup> and risk aversion.<sup>52</sup>

The U.S. National Strategy for Suicide Prevention recommends the use of suicide prediction tools,<sup>53</sup> and the European Psychiatric Association endorses using these tools as adjuncts to an individual psychiatric assessment.<sup>54</sup> Despite the putative advantages of such tools, current evidence to support their routine use in emergency departments and in primary care is weak.<sup>49</sup> The shortcomings of current evidence are reflected in suggestions that new risk-assessment models should be developed for specific populations, should not be evaluated on the basis of one performance metric (e.g., positive predictive value), should be considered as adjuncts to clinical decision making instead of being applied independently, and should have a high negative predictive value (to screen out low-risk persons and thus preserve resources).<sup>47</sup> Although machine-learning approaches based on large data sets may provide information on the causes of suicide, their role in suicide risk assessment is not known.

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#### INTERVENTIONS TO REDUCE SUICIDE RISK

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##### POPULATION-BASED MEASURES

Suicide prevention strategies can be used at the population level or can be targeted at high-risk

**Table 2. Tools for Assessing Suicide Risk.**

Tool*	Intended Population	Outcome When Originally Developed	Scale or Prediction Tool	Selection of Variables and Weighting	No. of Items	No. of Suicides in External Validation
Beck Hopelessness Scale <sup>43</sup>	General population (17–70 yr)	Hopelessness symptoms	Rating scale	Not tested, unweighted	20	62
Beck Depression Inventory <sup>43</sup>	General population (≥13 yr)	Depressive symptoms	Rating scale	Not tested, unweighted	21	76
Scale for Suicide Ideation <sup>43</sup>	General population	Suicidal ideation	Rating scale	Not tested, unweighted	20	30
Patient Health Questionnaire (PHQ-9) <sup>43</sup>	Primary care	Depressive symptoms	Rating scale	Not tested, unweighted	9	46
Beck's Suicide Intent Scale <sup>43</sup>	Self-harm	Suicidal ideation	Rating scale	Not tested, unweighted	20	76
ReACT Self-Harm Rule <sup>43</sup>	Self-harm	Repeated self-harm and suicide	Prediction tool	Multivariable model, unweighted	4	92
Columbia Suicide Severity Rating Scale (C-SSRS) <sup>44</sup>	General population, at risk groups	Suicidal intent and behavior	Prediction tool	Decision tree, unweighted	5	10
Army STARRS suicide prediction tool <sup>45</sup>	U.S. military, after psychiatric hospitalization	Suicide	Prediction tool	Multivariable model, weighted	14	Not available
Army STARRS suicide prediction tool <sup>46</sup>	U.S. military, after outpatient psychiatric visit	Suicide	Prediction tool	Multivariable model, weighted	61	Not available
OxMIS tool <sup>47</sup>	Severe mental illness	Suicide	Prediction tool	Multivariable model, weighted	17	139

\* OxMIS denotes Oxford Mental Illness and Suicide, and STARRS Study to Assess Risk and Resilience in Servicemembers.

groups or individuals. Population measures include restricting access to the means of suicide, particularly if certain methods are lethal and frequently used in a particular population. Worldwide, hanging accounts for approximately 40% of deaths by suicide, and pesticides account for 14 to 20%.<sup>55</sup> Pesticide restrictions have been evaluated in 16 countries, and bans of the sale of highly hazardous pesticides were associated with reductions in suicides in Sri Lanka, Bangladesh, and South Korea.<sup>55</sup> However, a trial of safe household storage of pesticides in Sri Lanka did not reduce suicides in a randomized trial with a cluster design.<sup>56</sup> Other common methods of suicide are jumping from heights and medication overdoses. Erection of barriers at potential suicide spots, such as bridges, tall buildings, and railway tracks, and smaller pack sizes of certain nonprescription medications that are used for suicide, such as acetaminophen and preparations with dextropropoxyphene, have led to reductions in suicide deaths by these means.

Data on the association between firearm possession and suicide differ according to country

and culture. In the United States, there were 14,542 homicides and 23,854 suicides involving firearms in 2017.<sup>4</sup> Analyses of individual-level data,<sup>15</sup> area-level data in large cities,<sup>57</sup> and state-level data<sup>58</sup> have shown associations between firearm ownership and suicide, and gun restrictions have been associated with lower overall suicide rates as well as lower rates of suicide with firearms.<sup>8</sup> The latter observation has been confirmed in trends in four states that implemented restrictive changes in firearm legislation during the 2009–2013 period.<sup>59</sup>

Population approaches to suicide prevention have focused mostly on institutionalized or incarcerated populations. These approaches include removing ligature points that present opportunities for hanging in psychiatric hospitals and prisons. The introduction of early intervention services for psychosis reduced suicides in Hong Kong.<sup>60</sup> Several studies have not confirmed the effectiveness of broad, school-based suicide prevention programs, and the justification for such initiatives has been questioned.<sup>61</sup> However, a pan-European study that involved raising awareness

**Table 3. Suicide Risk and Interventions in Specific Subgroups.\***

Subgroup	Suicide Rate <i>no./100,000</i>	Risk Factors	Interventions (Outcome to Be Prevented)
Children, adolescents, and young adults (age 10–24 yr)	10	Negative life events, mental disorders, substance misuse, access to lethal means	Psychological treatment — psychotherapy based on understanding one's mental state (self-harm in girls)
Older adults (age ≥70 yr)	43	Functional disability, social isolation, malignant diseases, chronic diseases	Telephone counseling (suicide); multifaceted program of psychoeducation, depression screening, group therapy, and clear referral pathways (suicide among rural women); integration of mental health into primary health care (self-harm)
Discharged psychiatric patients (first 90 days after discharge)	178	Recent self-harm, severe mental illness, first psychotic episode	Pharmacologic treatment for underlying disorders; psychological treatment — cognitive behavioral therapy, problem-solving therapy, or both (suicide)
Prisoners	23	Housing in single-occupancy cell, remanded status, life sentence, violent-offense conviction, psychiatric disorders, alcohol use disorders	Removal of ligature points (suicide)
Military and veteran populations	20	Early separation from service, recent deployment, lower rank, younger age, clinical depression, multiple disorders	Safety planning intervention, which involves prioritizing coping strategies and telephone contact to monitor risk (self-harm)
Nonheterosexuals	Same as rate for general population	Same as risk factors for general population	Addressing suicidal risks openly with clinicians and addressing internalized stigma (self-harm)
People who have harmed themselves	439 (1-yr rate)	Past self-harm, physical health problems, male sex, suicidal intent, violent self-harm (use of firearms, hanging, or cutting), age of 45–64 yr (vs. younger age)	Psychological treatment — cognitive behavioral therapy, problem-solving therapy, or both (self-harm)

\* Suicide rates refer to those in the United States, but the interventions are applicable to subgroups in all high-income (and possibly middle-income) countries. More detailed descriptions and references are provided in the Supplementary Appendix, available with the full text of this article at NEJM.org.

of mental health and suicide risk among students showed a reduction in suicide attempts.<sup>62</sup> Future innovations may include safety-planning apps that assist in identifying and removing lethal means of suicide, obtaining peer support, and accessing crisis support services. In the United States, Britain, and other high-income countries, national suicide prevention strategies have highlighted groups at high risk for suicide that should receive targeted interventions (Table 3 and the Supplementary Appendix, available with the full text of this article at NEJM.org).

#### PHARMACOLOGIC TREATMENTS

Most of the evidence in support of pharmacologic treatment to prevent suicide in populations with mental illness comes from observational studies. The few randomized trials of such treatment have been underpowered to study suicide and have relied on proxy outcomes (e.g., suicidal

ideas or depressive symptoms). Trials of antipsychotic medications as compared with placebo in patients with schizophrenia have shown reductions in suicide rates, but these results have been uncertain because of the small numbers of suicides.<sup>63</sup> In contrast, trials of lithium in patients with bipolar disorder or depression have been associated with more convincing reductions in suicide.<sup>64</sup> Most randomized trials of psychopharmacologic intervention have excluded patients with a history of suicidal ideation or behavior and those who are actively suicidal, limiting the generalizability of the findings. Specific pharmacoepidemiologic approaches, called “within-individual designs,” that account for factors that remain stable in an individual patient (e.g., background genetic risk and environmental adversities) have shown a 14% decrease in the incidence of suicidal acts and completed suicide among people treated with lithium for bipolar

INTEGRATING ASSESSMENT  
AND TREATMENT

disorder<sup>65</sup> and a 19% reduction among young people with attention deficit–hyperactivity disorder and high rates of coexisting psychiatric disorders who were treated with psychostimulants.<sup>66</sup> Medications for opiate use disorders (methadone and buprenorphine) have been associated with reduced rates of completed suicide among persons with addictions.<sup>67</sup> Treatments being investigated for suicide prevention in patients with depression include the anesthetic ketamine, electroconvulsive therapy, and repetitive transcranial magnetic stimulation, but these approaches have not been sufficiently studied.

**PSYCHOLOGICAL TREATMENTS**

Studies of psychological treatments for suicide prevention have mainly addressed how suicidal ideas and thoughts develop and their conversion into plans for self-harm; alternatively, they have focused on mental states associated with suicide, such as depressive and anxiety symptoms. A meta-analysis that included various psychological treatments showed that at the end of the treatment period, interventions that directly addressed suicidal thoughts and behaviors and provided strategies for coping with them had better outcomes than treatment for anxiety and depression, but these differences were diminished after 1 year.<sup>68</sup> Trials of cognitive behavioral therapy have shown a reduction in suicidal thoughts,<sup>69</sup> presumed to be mediated by reducing hopelessness. Mindfulness-based cognitive therapy, which combines cognitive behavioral techniques with meditation and deep breathing, has improved mood stability and problem solving in suicidal persons.<sup>70</sup> Dialectical behavioral therapy, a form of cognitive therapy involving both individual and group-based treatment that focuses on keeping people in therapy and helping them learn to manage emotions and learn mindfulness skills, has reduced self-harm in 12 trials but with small effect sizes.<sup>71</sup> A study of family therapy as compared with usual treatment for adolescents who had harmed themselves showed no reduction in suicides with family therapy.<sup>72</sup> Another study showed that Internet-administered self-help treatments may offer approaches for hard-to-reach groups, such as persons who have had negative health care experiences or persons with financial or time constraints that impede access to care,<sup>73</sup> but these findings were not replicated in a similar trial.<sup>74</sup>

It is advantageous to consider the following five points in assessing and managing the risk of suicide. First, a person who presents with suicidal thoughts may be at risk for suicide even if there are few overt symptoms of a psychiatric disorder. Second, suicide risk should be assessed by considering predisposing and precipitating factors, including recent life events. Third, the risk of suicide should be managed through regular follow-up and brief psychological therapy; for persons with symptoms of mental illness, pharmacologic treatment should also be considered. Fourth, the suicidal person, family members, and those who provide care should all take part in ensuring a safe environment, with removal of the means of suicide such as guns. Finally, if the risk of suicide is considered to be high or uncertain, the person should be referred immediately to mental health services, and the use of risk-assessment tools should be considered to aid risk stratification and communication among services. Mental health professionals have emphasized that developing and maintaining a therapeutic relationship is central to reducing suicide risk.<sup>75</sup>

The following steps can be taken in evaluating someone who has inflicted self-harm: inquire nonjudgmentally about the incident to establish the intent of the self-harm; determine how ideation was acted on; assess the risk of repetition, using structured approaches that can be supplemented with risk-assessment tools; identify psychological, social, and psychiatric needs; and establish an individual treatment plan that incorporates safety planning and restriction of lethal methods.

Management of suicidality calls for a comprehensive approach to assessment and treatment. Assessment should focus on past suicidal behavior, openly addressing ongoing suicidal ideas and psychosocial needs. Assessment of the risk of self-harm and completed suicide may increasingly draw on new technologies such as clinical decision-making tools and safety planning to establish evidence-based practices.

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