The role of prediction in suicide prevention

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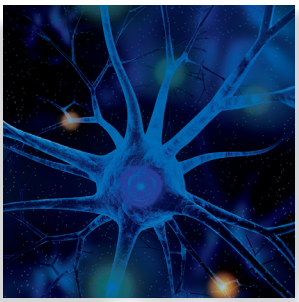

It is widely believed that suicide prevention involves the consideration of risk and protective factors and related interventions. Preventative interventions can be classified as "universal" (targeting whole populations), "selective" (targeting higher-risk groups), and "indicated" (protecting individuals). This review explores the range of preventative measures that might be used commensurately with different types of suicide prediction. The author concludes that the best prospects for suicide prevention lie in universal prevention strategies. While risk assessments do generate some information about future suicide, suicide risk categorization results in an unacceptably high false positive rate, misses many fatalities, and therefore, is unable to usefully guide prevention strategies. The assessment of suicidal patients should focus on contemporaneous factors and the needs of the patient, rather than probabilistic notions of suicide risk.

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Keywords: *mental health; prevention; risk assessment; risk factor; suicide*

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Introduction

The World Health Organization (WHO) has called on nations to make suicide prevention a "global imperative."[1] It recommends that suicide prevention should be achieved by the systematic consideration of "risk and protective factors and related interventions."[1] Specifically, the WHO advocates that universal strategies should target whole populations, selective strategies should target higher-risk groups, and indicated strategies should protect individuals at risk. This review explores the prediction of suicide and commensurate preventative measures, while defining prediction as any method that can identify groups or individuals at an increased probability of suicide.

In order to take an evidence-based approach to acting on the global imperative to reduce suicide, it is important to have a clear understanding of the risks of suicide according to methods of prediction and what commensurate preventative measures might be. This paper will examine plausible opportunities for prevention afforded by suicide predictions based on international suicide rates, demographic factors within nations, mental disorders, and the setting of mental health care, before considering more traditional notions of a suicide risk assessment (for examples see *Table I*). To this end,

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the strength of the suicide predictions is considered using the statistical metrics of sensitivity (the proportion of all suicide cases included in the higher-risk group), discrimination (effect size distinguishing the probability of suicide in higher and lower suicide risk groups), and the positive predictive value (the probability that patient in a higher-risk group will die by suicide). Only once these metrics have been established can the question be asked–exactly what type and how much prevention is suitable in light of a suicide prediction? For example a burdensome or inconvenient targeted intervention, even if highly effective against suicide, can only be commensurate with a prediction that carries a high positive predictive value, such that only few people will suffer unwarranted consequences. Similarly, a selective intervention that advantages a higher-risk group can only be commensurate with a degree of discrimination between lower-risk and higher-risk groups if it does not unfairly disadvantage the lower-risk group that miss out on the intervention.

Prediction and prevention at a national level

Worldwide in 2015, about 788 000 people died by suicide at a global rate of 10.7 per 100 000 person-years (or about 1 in 9 350 people per annum).[2] That year, national suicide rates were lowest in the small Caribbean nations of Antigua and Barbuda, Barbados and Grenada, each of which had suicide rates below 1 per 100 000 person years among populations of fewer than a quarter of a million. However, in 2015, suicide rates also varied remarkably between populous nations, ranging from 1.4 per 100 000 person years in Jamaica to 34.6 per 100 000 person-years in Sri Lanka (*Table II*).[2] While some of this international variation might be a result of differences in the definition suicide or methods of data collection, there is little doubt that there are large and real differences in national suicide rates. Decades of work standardizing the reporting of suicide has not resulted in converging rates, and national suicide rates are notably stable on a year-to-year basis.[3]

Hence, suicide rates between nations can vary by more than an order of magnitude. This suggests that some preventative measures might be justified in nations that have a higher suicide rate, but not in lower suicide rate nations. For example, although two nations might have similar problems with agricultural pests, the overall benefit of restricting access to toxic pesticides might clear in high suicide rate countries like Sri Lanka (where 1 in 2900 die by suicide each year) but might be less obvious in low suicide rate countries like Jamaica (where as few as 1 in 74 500 die by suicide each year).

The reasons for the marked heterogeneity in international suicide rates are not fully understood. One important observation is that national suicide rates by particular lethal methods (such as hanging, poisoning,

Example of a group with a predicted increased rate of suicide	Approximate increased odds of suicide (measure of discrimination)	Approximate absolute risk (Equivalent of positive predictive value)	The proportion of all suicides identified (Equivalent of Sensitivity)	Example of a possible preventative strategy
National group – Sri Lanka 2015[2]	About three times the global suicide rate	1 in 2900 per year	All national suicides	Universal preventative measures such as the restriction on pesticides
Demographic group – men in the USA 2015[2]	Men had over three and half times the suicide rate of women	1 in 5100 per year	About 75% of all suicides	Reducing men's access to firearms
Diagnostic group – Schizophrenia[27, 70]	About a ten-fold risk	1 in 20 lifetime risk	About 5% of all suicides	Earlier treatment of psychosis and clozapine
Level of psychiatric care – Recently discharged psychiatric patients[41, 70]	About a 100-fold risk compared to the general population	1 in 4000 in the first three months post discharge	About 5% of all suicides	Higher proportion of patients followed up post discharge
Higher-risk psychiatric patients[59]	About a five-fold risk	1 in 18 over 5 years	56% of all patient suicides	Not clear
Individual suicide risk	Not known	Not known	Likely to be small	Hospitalization?

Table I. Examples of predictive groups, measures of suicide risk, and possible preventative strategies.

gassing, shooting, jumping, and drowning) vary greatly between nations[4] but tend to be stable within nations on a year-to-year basis.[3] This predictability of method-specific suicide rates underpins most universal measures to prevent suicide. Well-known examples include the substitution of natural for coal gas in the United Kingdom in the 1960s,[5] the regulation of firearms in Australia in the 1990s,[6] and the trend towards bans on highly hazardous pesticides in many countries.[7] Each of these universal measures resulted in reductions in both cause specific suicide mortality and a drop in suicide rates. Other universal preventative measures are the reduction in analgesic pack size,[8] the substitution of barbiturates with benzodiazepines,[9] the placement of barriers at jumping hotspots,[10] measures to decrease alcohol consumption,[11] and changes to media reporting of suicides.[12] In each of these cases (with the slightly contentious exception of the regulations in firearms) suicides rates have been reduced at little or no cost or inconvenience to the whole population.

Some potential universal prevention strategies come at a greater cost. Examples include, better access to health care[13] and measures to reduce unemployment.[14] Other universal, potentially important measures might be inexpensive but hard to achieve, for example reducing suicide by reducing the stigma associated with accessing mental health care.[15]

Despite the challenges faced by nations with a high suicide rate, universal measures hold the best hope for global suicide prevention. To illustrate, if global suicide rates were similar to those of Jamaica, Indonesia, or Pakistan, suicide would fall from its current place in the top 20 causes of death to about the hundredth cause of global death.[16]

Examples of countries with a lower suicide rate than the global average in 2015 and their age-standardized suicide rates (per 100 000 population)		Examples of countries with a higher suicide rate than the global average in 2015 and their age-standardized suicide rates (per 100 000 population)	
Country	Rate	Country	Rate
Jamaica	1.4	Switzerland	10.7
Pakistan	2.5	Ireland	11.1
Indonesia	3	Papua New Guinea	11.9
Egypt	3.1	South Africa	12.3
Greece	3.2	France	12.3
Philippines	3.8	USA	12.6
Saudi Arabia	3.9	Argentina	13.9
Iraq	4.1	Finland	14.2
Mexico	5	Japan	15.4
Israel	5.4	Hungary	15.7
Italy	5.4	India	16
Brazil	6	Russian Federation	17.9
Bangladesh	6	Zimbabwe	18
Spain	6	Poland	18.5
UK	7.4	Republic of Korea	24.1
China	8.5	Angola	25.9
Turkey	8.6	Lithuania	26.1
Germany	9.1	Kazakhstan	27.5
Netherlands	9.4	Mongolia	28.1
Canada	10.4	Guyana	30.6
Australia	10.4	Sri Lanka	34.6
†WHO 2015[2]			

Table II. Sample of National Suicide Rates in 2015†.

Prediction and prevention according to demography

In addition to heterogeneity in suicide rates between nations, major differences in suicide rates can be found according to demographic characteristics within national populations. Selective prevention strategies based on the higher suicide risk of a demographic group are based on the assumption that any inconvenience caused by a prevention strategy can be borne by all members of the risk group and that its benefits should be denied those outside the group. While this may seem common sense, it can lead to perverse outcomes.

Consider the example of the male sex. Being a man is undoubtedly the most prevalent global risk factor for suicide. Worldwide, more than twice as many men than women suicide, and in high-income countries rates of male suicide are often three times female rates.[1] In many countries, the male sex can be considered to have a sensitivity for suicide of about 70% (because 70% of all suicide victims are male) and male sex discriminates for future suicide with much the same or greater effect size as suicidal thoughts and behaviors (that typically confer an increased odds over those without suicidal thoughts and behaviors of about two).[17] Al-

though the positive predictive value of suicide according the higher-risk category of being male is very low, a dramatic fall in global suicide would be achieved if men could somehow be coaxed into becoming more like women with respect to behaviors that are associated with suicide. Hypothetically, reducing men's access to high-lethality methods of suicide and reducing their alcohol consumption would be likely to reduce suicide significantly.[18] While there may be excellent reasons to place gender-based restrictions on the possession of firearms and alcohol consumption, in reality, any attempt to do so would be judged to excessively burden the vast majority of men who like to drink or shoot and will never die by suicide.

Similar arguments can be made about a wide range of at-risk societal groups, including of older people,[19] sexual minorities,[20] indigenous populations,[21] and the recently unemployed.[22] In each of these examples there is an association between group membership and suicide but a low absolute suicide risk, meaning that commensurate preventative interventions have to be unobtrusive and benign. Perhaps the most important measures to reduce suicide among particular demographic groups would be to reduce the stigma of mental disorder in higher-risk groups[23] and increase their access to health care[24] but again, it would be hard to argue that reduction in stigma and better access to health care are not broader societal goals and therefore should be universal, rather than selective, strategies.

Prediction and prevention according to mental disorder

Almost all mental disorders are associated with an increase in the risk of suicide and mental disorder is a plausible predictor of suicide. It has been estimated that as many as 90% of suicides in high-income countries are by people with mental disorder, suggesting that psychiatric diagnosis has a sensitivity for suicide of 90%.[25] Mental disorder is also quite a strong discriminator of suicide risk. One meta-analysis found that compared to the general population, those with major depression have a twenty-fold risk of suicide, while there is a fifteen-fold for bipolar disorder, eight-fold for schizophrenia and seven-fold for personality disorders.[26] The positive predictive value associated with lifetime suicide in mental disorder is far from trivial, estimated to be over 5% for schizophrenia,[27] 4% for those hospitalized with affective disorders, and over 2% for never hospitalized people with an affective disorder.[28]

The strength of the association between mental disorder and suicide suggests that the treatment of mental disorder might be an efficacious way of preventing suicide. However, the view that suicide can be prevented simply by the treatment of mental disorder is both overly simplistic and overly optimistic.

Sadly, the evidence for the suicide preventing properties of psychological therapies[29] and medical psychiatric treatment[30] is less strong than might be generally believed. Recent meta-analyses of the mortality in trials of commonly prescribed antidepressants have failed to demonstrate a protective effect against suicide.[31,32] Similarly there is little evidence for the suicide-reducing effects of antipsychotics[33] or electroconvulsive therapy.[34] There is some evidence that clozapine can reduce suicide risk in schizophrenia[35] and that lithium is protective against suicide in major mood disorders,[36] but it is doubtful whether suicide prevention afforded by these treatments alone can justify their serious side effects. This is not to say that antidepressants, antipsychotics, and mood stabilizers should not be prescribed for suicidal patients—but the benefits of a medication and its effectiveness in suicide prevention are not always closely related. The symptoms of depression, schizophrenia, and bipolar disorders are often well-controlled by these medications and their prescription is easily justified, irrespective of any perception of suicide risk. Moreover, some treatments for mental disorder are used ethically even if they increase the risk of suicide. Benzodiazepines are an evidence-based treatment for alcohol withdrawal and some anxiety states but are associated with an increased suicide risk, likely because of their disinhibiting effects and toxicity in overdose.[37]

Prediction and prevention according to levels of psychiatric care

The higher levels of psychiatric care provided in emergency departments and by psychiatric hospitalization have recently emerged as important suicide risk factors that offer plausible opportunities suicide prevention.[38,39] In the modern era of psychiatric deinstitutionalization suicide rates among currently psychiatrically hospitalized people are typically about 50 times community suicide rates,[40] rising to an astonishing 100-fold risk dur-

ing the 3 months after discharge.[41] This suggests that a current or recent psychiatric admission is the strongest known discriminator for suicide. Viewed through the lens of a predictive test, about 20% of all suicides are previously hospitalized patients (sensitivity)[38] and the long-term suicide risk of hospitalized patients (positive predictive value) has been reported to be 2.5% for men and 1.5% for women.[42]

Current and former inpatients are a well-defined group who might benefit from selective suicide preventative measures. While the absolute risk of suicide associated with inpatient care might not justify prolonged hospitalization or other restrictions on liberty,[43] some less intrusive suicide preventative measures seem to be quite effective. In the United Kingdom, inpatient suicide rates have declined in response to a range of measures including the reduction in hanging points[44] and by policies for regular observation in hospital.[45] Moreover, reducing the stigma and trauma associated with psychiatric admissions might prevent some suicides.[46, 47]

Prediction and prevention using higher-risk categories

Suicide risk assessment is widely recommended in clinical practice[48-51] and often has the explicit aim of creating suicide risk groups denoted by the terms high, medium- and low-risk.[52,53] While there is no agreement about how to perform a suicide risk assessment, inquiring about suicidal thought and behaviors is usually considered central to the task.[54,55] Specialist mental health services often insist on semi-structured risk assessment using lists of risk factors, and some researchers advocate for suicide risk questionnaires or scales.[56] Each of these approaches meets this paper's definition of prediction as a method that can identify groups or individuals at increased risk of suicide.

A 2017 review examined the predictive properties of suicide risk assessment quantified by recent meta-analyses.[57] The review located meta-analyses that found that no risk factor,[58] or combination of risk factors,[59] was so strongly associated with suicide as to be clinically useful. One meta-analysis found that the positive predictive value of suicidal ideation for suicide was about 1% per annum,[60] while a second found that higher-risk categorizations based on multiple risk factors discriminated between higher-risk and lower-risk groups with pooled odds of 4.84 and a sensitivity of 56%.[59] Two meta-analyses calculated the positive predictive value among "higher-risk" patients to be 5% in the long-term.[59, 61]

These replicated, robust, and ultimately disappointing results suggest that while risk assessments do provide some information about future suicide, this information is limited and a very limited set of selective suicide-preventing interventions might be rationally used on the basis of a higher-risk categorization. If as few as 5% of higher-risk people die by suicide in the long term, any commensurate suicide reducing intervention must be both benign and cost-effective so as to be acceptable to the remaining 95%. Furthermore, if such a benign and cost-effective long-term or long-lasting intervention were available, there would be very strong arguments that the same intervention should be offered to lower-risk patients, among whom over 40% of suicides occur.

Prediction and prevention of suicide by individual patients

Suicide risk assessment aims to reduce the uncertainty about future suicide. So far I have assumed that this uncertainty is statistical in nature and that it can be measured using metrics of sensitivity, discrimination, and positive predictive value. However, uncertainty is often regarded as having two components, the first component resulting from chance factors, is variously denoted as statistical, probabilistic, or aleatory uncertainty and the second component being epistemic, resulting from a lack of knowledge.[62-64] Both types of uncertainty are at play in medical practice. For example, an intravenous drug user is at increased probability of contracting human immunodeficiency virus—but on presentation with an opportunistic infection, whether he or she has acquired immunodeficiency syndrome is not a matter of chance but of facts that can be resolved by increased knowledge, in this case by performing blood tests.

There is little doubt that aleatory factors play a major role in suicide. The potential range of future events experienced by people is large and unknowable. Further, the degree of complexity of a person's biology, psychology and social setting strongly points to the role of non-linear dynamics, rendering suicide unpredictable even if all the initial risk and protective factors could be known.[65] However, here I would like to briefly consider whether increased knowledge of an individual person can meaningfully reduce uncertainty about suicide to the point of indicating measures to prevent an

individual suicide. On initial consideration this seems unlikely because the law of large numbers dictates that uncertainty in a single trial is always greater than the uncertainty of repeated trials and because of the empirical evidence that statistical or actuarial approaches are generally better at forecasting human behavior than clinical judgment.[66]

However, in some circumstances clinicians might come to a high degree of certainty on epistemic grounds. Consider the example of a young, employed, non-mentally ill, and never psychiatrically admitted mother who was found to have written a suicide note before taking a deliberate and well-planed overdose of a highly lethal substance. The lack of many established suicide risk factors and the protective factor of children suggest a lower suicide risk, but epistemic knowledge of the details of the suicide attempt and of the circumstances described by the patient might lead a clinician to make a judgment that the patient is suicidal. In practice this sort of epistemic judgments might not be rare.

Two questions then arise. How reliable are epistemic assessment of future suicide and what might be rationally done to prevent suicide in the event of an epistemic judgment of imminent suicide?

The answer to the first question is not known. What is known is that nomothetic risk factors (risk factors possessed by classes or cohorts of individuals), including the presence of suicidal thoughts and behaviors, alone cannot lead to certainty about suicide. If judgments about suicide are to reach a very high level of certainty this can only be achieved with specific, proximal, and idiographic factors (those that are unique to the individual) and not with what are traditionally considered to be risk or protective factors. Moreover, this has to be a contemporaneous judgment (given the weakness of predictive algorithms) involving as little in the way of forecasting as possible. This is not to say that this form of certainty is not sometimes possible, but it does imply that clinicians should examine the evidence before them very carefully, and that they should give less weight to traditional risk factors when making judgments about suicidality than is generally held.

Assuming that a clinician has formed the view that the patient is suicidal, what then is the appropriate preventative step? The most common response is that the patient should be observed and protected until their distress has resolved. This observation and protection often involves admission of the patient to a psychiatric hospital. While it is generally assumed that hospitalization can prevent suicide, this has never been demonstrated empirically. Moreover, there is a minority view that the loss of autonomy, trauma, and stigma associated with hospitalization contributes to suicides in the inpatient and setting[47] and in the post-discharge period.[67]

How the limits of suicide prediction impact on prevention

The limits of suicide prediction appear to be profound. The single strongest discriminator of suicide risk is status as a current or recent psychiatric hospital patient, and this association is more than an order of magnitude stronger than the degree of discrimination made possible by other forms of suicide risk assessment.

In the future some improvement in risk assessment might flow from the identification of hereto-unknown risk factors[68] or by new ways of combining established risk factors, such as with machine learning[69] and other methods derived from nonlinear dynamics.[65] However new methods of suicide risk assessment might only be useful if they have powers of statistical discrimination greatly exceeding existing methods.

There may also be a role of real-time monitoring using new wearable technologies. However, even if proximal measures obtained by real-time monitoring do have a much stronger discrimination between suicide and non-suicide than conventional risk factors, the positive predictive power will not be increased and may even be lower because of the intrinsically low base rate of suicide over short time frames.

Moreover, the limitations of prevention also impact on the usefulness of suicide prediction. There is simply no value in a prediction that cannot lead to an effective preventative measure. While the positive predictive value can be assumed to be a relevant factor in judgments about ethics of exposing false positive cases to adverse effects of suicide preventing interventions, the effectiveness of the interventions is also relevant. Despite the widespread adoption of suicide risk assessment there are no published randomized trials demonstrating that risk assessment can guide any suicide-reducing interventions to the point of reducing the overall prevalence of suicide in the assessed group, and it remains to be seen if this evidence threshold can be achieved by any new suicide-predicting method.

Accepting the limits of suicide prediction

The best prospects for global suicide prevention do not involve traditional notions of suicide prediction or risk assessment. Reducing the suicide rate in countries with a high suicide rate or reducing the suicide rate of men to nearer that of women would achieve large reductions in global suicide rates. Attention to the care of hospitalized patients cannot be ignored because of the extraordinary suicide rate in this group, but this can only be expected to have a modest effect on total suicide rates because most suicides are by people who have never been in a psychiatric hospital. More generally, psychiatric treatment should be offered to all people in order to alleviate their burden of symptoms and should not be rationed or justified by notions of who is likely or unlikely to suicide. While some patients will generate more concern about suicide than others, knowledge of the limited sensitivity, modest power of discrimination, and the very low positive predictive value of suicide risk assessment should assist clinicians in the task of joint decision making with their suicidal patients.

Refraining from the temptation to predict suicide in clinical psychiatric practice might even assist suicide prevention. Low positive predictive values mean that most people who receive treatment because of a higher-risk categorization will never die by suicide and the limited sensitivity means that as almost half of the patients who do die by suicide might have been deprived of preventative measures after a lower-risk categorization. Epistemic judgements about future suicide should be made very carefully and only after all the available evidence is gathered. Valid statistical risk factors might contribute to such an epistemic call about suicidality, but this contribution should be modest.

Rather than attempt to make a suicide prediction, clinicians should focus on improving the interaction with the patient so as to foster hope, reduce the patient's distress and suffering, and maximize the therapeutic alliance. A comprehensive assessment of the patient's current needs should follow. These needs will often include the need to address modifiable factors that are associated with suicide, for example treatment of substance use, but most such needs should be met irrespective of the associations with future suicide. Needs assessments are not probabilistic and should lead to treatments being offered to all patients irrespective of perceived suicide risk.

Finally, psychiatrists should explicitly acknowledge the limits of prediction of suicide to our patients and their families and health care systems providers. Lowered faith in prediction and acceptance of the limits of prevention might have the benefit of reducing unnecessarily restrictive interventions and might allow clinicians to focus on more achievable treatment goals and the patient's path to recovery. ❑

Disclosure/Acknowledgements: I thank Navneet Kapur and Amy Corderoy for their assistance with the manuscript. The author has given evidence in the NSW coroners and other Australian courts regarding suicide risk assessment. The author has no conflicts of interest to declare.

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El papel de la predicción en la prevención del suicidio

En general, se cree que la prevención del suicidio implica la consideración de los factores de riesgo y de protección, y las intervenciones relacionadas. Las intervenciones preventivas se pueden clasificar como "universales" (dirigidas a toda la población), "selectivas" (dirigidas a grupos de mayor riesgo) e "indicadas" (protección a las personas). Esta revisión explora el rango de medidas preventivas que podrían usarse de manera acorde con los diferentes tipos de predicción de suicidio. El autor concluye que las mejores perspectivas para la prevención del suicidio se encuentran en las estrategias universales de prevención. Si bien las evaluaciones de riesgo sí aportan cierta información sobre futuros suicidios, la categorización del riesgo de suicidio genera una frecuencia, inaceptablemente alta, de falsos positivos; deja de lado muchas muertes y es, por lo tanto, inapropiada para guiar de manera útil las estrategias de prevención. La evaluación de los pacientes con tendencias suicidas debería centrarse en los factores del momento y las necesidades del paciente, más que en las nociones probabilísticas de riesgo de suicidio.

Le rôle du pronostic dans la prévention du suicide

Il est largement reconnu que la prévention du suicide implique la prise en compte des facteurs de risque et de protection et des interventions qui s'y rapportent. Les interventions de prévention peuvent être « universelles » (ciblant toutes les populations), « sélectives » (ciblant des groupes à haut risque) ou « indiquées » (protégeant les individus). Cet article explore l'éventail des mesures préventives qui pourraient être utilisées proportionnellement aux différents types de pronostic de suicide. Pour l'auteur, les meilleures perspectives de prévention du suicide résident dans les stratégies universelles de prévention. Les évaluations du risque génèrent certaines informations sur le suicide à venir, mais la catégorisation du risque suicidaire entraîne un taux inacceptablement élevé de faux positifs, passe à côté de beaucoup de décès et est donc inappropriée pour guider les stratégies de prévention. L'évaluation des patients suicidaires devrait se concentrer sur des facteurs contemporains et les besoins des patients plus que sur des notions de probabilité du risque suicidaire.