Prognostic Models to Detect and Monitor the Near-Term Risk of Suicide

State of the Science

Cynthia A. Claassen, PhD, Judith D. Harvilchuck-Laurenson, PhD, Jan Fawcett, MD

Aspirational Goal 3 of the National Action Alliance for Suicide Prevention's Research Prioritization Task Force research agenda is to "find ways to assess who is at risk for attempting suicide in the immediate future." Suicide risk assessment is the practice of detecting patient-level conditions that may rapidly progress toward suicidal acts. With hundreds of thousands of risk assessments occurring every year, this single activity arguably represents the most broadly implemented, sustained suicide prevention activity practiced in the U.S. Given this scope of practice, accurate and reliable risk assessment capabilities hold a central and irreplaceable position among interventions mounted as part of any public health approach to suicide prevention.

Development of more reliable methods to detect and measure the likelihood of impending suicidal behaviors, therefore, represents one of the more substantial advancements possible in suicide prevention science today. Although past "second-generation" risk models using largely static risk factors failed to show predictive capabilities, the current "third-generation" dynamic risk prognostic models have shown initial promise. Methodologic improvements to these models include the advent of real-time, in vivo data collection processes, common data elements across studies and data sharing to build knowledge around key factors, and analytic methods designed to address rare event outcomes. Given the critical need for improved risk detection, these promising recent developments may well foreshadow advancement toward eventual achievement of this Aspirational Goal.

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Introduction

An estimated 678,000 U.S. citizens were treated for a suicide attempt in some type of medical setting in 2008.[1] This number suggests that a suicide risk assessment would have been done at least once every 2 minutes throughout that calendar year with a treatment-seeking, suicide-attempting patient. A larger number of additional assessments would have been conducted with individuals who had suicidal ideation but no recent suicidal behavior. With hundreds of thousands of risk assessments occurring annually, this single activity arguably represents the most broadly implemented, sustained suicide prevention activity practiced in the U.S. Given this scope of practice, accurate and reliable risk assessment capabilities hold a central, irreplaceable position among interventions mounted as part of any public health approach to suicide prevention.

The development of more accurate and reliable prognostic tools for detecting risk would therefore be one of the most substantial research advancements in suicide prevention science today. In clinical settings, such advancement would almost certainly precipitate models of care tailored more appropriately to actual risk levels, replacing existing probabilistic treatment models. In research trials, progress in risk detection would likewise clear the way for empirically validated tools capable of detecting heightened risk status and providing more nuanced indicators of treatment effectiveness across time.

Aspirational Goal 3 of the National Action Alliance for Suicide Prevention's Research Prioritization Task Force (RPTF) prioritized research agenda is to "find ways to assess who is at risk for attempting suicide in the immediate future." This goal is differentiated from other Aspirational Goals in that it addresses issues related to the task of identifying and predicting near-term suicide

From the Department of Psychiatry (Claassen), University of North Texas Health Science Center, Fort Worth, Texas; The National Action Alliance for Suicide Prevention's Research Prioritization Task Force (Harvilchuck-Laurenson), Washington, District of Columbia; and the Department of Psychiatry (Fawcett), University of New Mexico Health Sciences Center, Albuquerque, New Mexico

Address correspondence to: Cynthia A. Claassen, PhD, c/o Psychiatry, University of North Texas Health Sciences Center, 3500 Camp Bowie Blvd., Fort Worth TX 76107. E-mail: cindy.claassen@unthsc.edu.

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risk at the individual patient level (as opposed to research directed at group screening practices).

The topic is broad and complex, related bodies of research large, and space limited. This discussion of potential research pathways is therefore limited to examination of some more frequently encountered scientific challenges in research aimed at improving capacity to estimate the probability of near-term suicidal acts among suicidal individuals.

As per CDC definitions, *violence* is an umbrella term that encompasses both self- and other-directed aggressive acts. *Self-harm* is likewise an umbrella term that includes self-directed, violent acts with and without suicidal intent.[2] *Elevated* or *acute risk* as the term is used here refers to conditions that may progress rapidly to suicidal behavior. The term *imminent risk* is a legal but not scientific term that incorrectly implies that mental health professionals have the ability to precisely identify "imminence"—the high probability of an impending suicidal act.[3] This term is therefore not used in our paper. In contrast, *near-term risk* refers to a time period during which an increased propensity for suicidal behavior exists. No time frame is attached to the term because no research is available to inform an estimate of the usual duration of near-term risk conditions.[4] *Chronically elevated suicide risk* is a condition under which elevated risk continues over longer periods of time—often (but not always) due to specific, intractable neuropsychiatric conditions (e.g., certain brain lesions) or the presence of relatively immutable psychosocial or demographic factors.[5]

The official nomenclature of the CDC suggests that *suicidal intent* involves "evidence (explicit or implicit) that, at the time of [an] injury, the individual intended to kill [the] self or wished to die, and that the [suicidal] individual understood the probable consequences of his or her actions."[2] *Static risk factors* are defined here as those factors that are fixed and historic (e.g., demographics, trauma history), and *dynamic risk factors* are defined as variable internal or external factors that may fluctuate in intensity over a short period of time.[6] Finally, *risk assessment* is defined as the process of collecting data on factors that signal a person's elevated risk.

Challenges in Work to Detect and Monitor Near-Term Risk

Suicidal behaviors appear to originate out of complex, multi-level macro- to micro-level interactions involving biological, psychological, interpersonal, and sociologic factors. The research pathway toward better prediction of suicide risk includes studies to forge, calibrate, and cross-validate a series of well-articulated prognostic models that stratify risk and project outcomes for groups of high-risk individuals.[7]

In other biomedical fields, such models have improved reliability in establishing diagnosis, forecasting outcome, and predicting treatment response.[8] The prognostic modeling efforts in suicide prevention are undergirded by a rich research tradition in the more generalized violence prevention field where current risk detection and prediction modeling efforts represent a third "generation" of such efforts.[9] First-generation decisional models used expert opinion or structured clinical judgment as their "gold standard" to detect risk and identify suicidal behavior. In the U.S. tradition, studies by Littman, Faberow, and Shneidman[10] at the Los Angeles Suicide Prevention Center illustrate this approach.

Second-generation prognostic models incorporated static risk factors (or factors that may change over time but are measured only at baseline and treated in modeling as static) in risk detection and prognostication efforts. Pokorny's (1984) landmark study[11] of suicides among 4,800 consecutively admitted Veteran psychiatric subjects is perhaps the best-known second-generation U.S. prognostic modeling exercise. In that study, demographic factors and baseline ratings of psychopathology, hopelessness, inpatient behavior and hygiene were entered into regression analysis. In all, 28% of 100+ criterion variables included in the study were significantly correlated to suicide-related outcomes, limiting the clinical utility of any of them for differentiating outcomes. Other second-generation suicide risk modeling exercises have produced similar results.[12,13]

Third-generation violence prediction models incorporate dynamic risk elements into their algorithms. For instance, in the (other-directed) violence literature, factors such as current disinhibition due to substance use,[14] relative inaccessibility of protective social support[15] or of access to care[16] are regarded as "rapidly changing acute risk factors."[14] In suicide risk assessment, preliminary success with a third-generation model came when the Collaborative Program on the Psychobiology of Depression[17–19] successfully differentiated depressed patients who later completed suicide on the basis of a model that included severe comorbid state anxiety. Although this finding has not been replicated, several studies have produced supporting data using various designs.

A variety of potentially dynamic biopsychosocial conditions that may affect near-term risk status are currently under investigation, including changes in neurobiology,[20] cognitions,[21] disturbed interpersonal relationships,[22] increased negative life stress with accompanying decrement in coping efficiency,[23] affective states,[24] and implicit psychological associations.[25]

Challenges in Constructing a Third-Generation Prognostic Model of Suicide Risk

A host of conceptual, logistic, and methodologic challenges have historically frustrated efforts to forge empirically validated prognostic models of suicide risk, and many of these challenges still pose formidable barriers to adequate study design. Some of the more common challenges are shown in Table 1 and briefly reviewed below.

Defining "Elevated-Risk" Conditions

Although the field has largely moved away from a view that there is a singular causal pathway leading to suicidal behavior, the multidimensional, transactional nature of common pathways have not been explicated in sufficient detail to inform study decision making. A time-honored view of the "suicidal process" adopted by many clinicians and researchers suggests that suicide-attempting individuals move through the "intention–plan–action" continuum in a predictable fashion—that is, an early death wish is subsequently augmented by intent and a suicide plan before the act itself.[26]

However, for the majority of individuals, ideation does not progress to suicidal behavior, and other ideating individuals transition to attempts without ever planning the act.[27] Competing, environmental–biological models regard suicidal behavior as the expected result when a critical level of stressors occurs within a diathesis,[28] when a threshold level of stressors occurs in close temporal proximity in a kind of dose–response equation,[29] or when very specific interpersonal stressors are present in the context of specific past learning.[22]

The Role of Suicidal "Intent"

American researchers have often drawn a clear distinction between suicide attempts and non-suicidal self-harm, and decisions about how to operationalize the suicidal "intent" construct therefore are critical to study design. Intent is variously understood to be a unitary cognition, a psychological "state," a biological condition, and a summative, multi-factorial metric. Much is unknown about the nature of suicidal intent, such as whether it waxes and wanes in a fashion that corresponds to subtle fluctuations in the likelihood for near-term self-harm, the accuracy of retrospective self-report, its prognostic capacity, and its role in impulsive acts. Assumptions about the construct will affect study design and outcome and should therefore be carefully articulated.

Table 1. Developing prognostic models for use in suicide risk assessment: challenges and suggested approaches

Study design question	What is needed
What exactly is "elevated risk" (e.g., do such conditions resemble a "continuum," "state," "process," "threshold," or "tipping point")?	• Clear articulation of assumptions about the nature of static and progressive suicidal conditions
What is suicidal "intent" and what is its relationship to outcome?	• Additional analyses of the correlations between commonly used measures of intent and outcomes • Further theoretic and empirical work on the nature, utility, and definition of the "intent" construct
What dynamic factors commonly increase risk levels? What are the contexts in which these factors most readily elevate risk?	• Real-time, nuanced data collection among suicidal persons to assess the quality and fluctuations in their suicidal conditions and those factors associated with progression in relation to adverse experience and stress levels • The use of common data elements across studies to systematically build a body of knowledge around important dynamic risk constructs
When do protective factors protect?	• Identification and clear articulation of assumptions about common protective factors that impact suicide risk • Inclusion of measures of protective factors and resilience in prospective data collection
How should risk and protective factor data be synthesized into meaningful prognostic models of risk?	• Modeling exercises comparing the prognostic value of multiple data synthesis approaches

What analytic treatment should be used?	• Multi-level modeling strategies, perhaps adapted from the other-directed violence literature
	• For rare event outcomes:
	  • Development of surrogate "end-points"/outcome measures
	  • Development and use of novel analytic strategies that combine candidate predictors for maximal explanatory power
	  • Use of statistical approaches designed for rare event analyses

Dynamic Correlates of Acute Risk

The task of prognostic suicide models is to identify a set of criterion variables with sufficient specificity to effectively predict risk in a given suicidal individual. Yet second-generation suicide risk models have identified an almost overwhelming number of nonspecific, static risk factors, producing a body of research that has been described as both "daunting" and conceptually "imprecise."[30] Well-articulated, precise measurements of variables intentionally selected to contribute knowledge to a well-vetted scientific base are needed in next-generation modeling. The common data elements movement described below may help realize this objective.

Protective Factors

The relevance of three constructs that affect risk in prognostic models is almost universally recognized, yet detailed examinations of how these factors mediate the threat of self-harm have not yet emerged. *Protective factors* are understood as "conditions or attributes that mitigate or eliminate risk" (e.g., skills, strengths, resources, supports, or coping strategies present in individuals, their personal support system, or the surrounding culture),[31] and at least some protective factors are known to differentially mitigate risk by context. In contrast, *psychological resilience* is an individual's innate "trait-like" capacity to cope with stress and adversity,[32] and the *absence of risk* occurs when no significant adversity or stress is acting on the individual. Careful consideration of the role of these factors is warranted during study design.

Data Synthesis in Prognostic Risk Models

Although multi-level analyses are the preferred approach in third-generation modeling exercises,[9] methods for integrating various pieces of risk and protective factor information into final overall risk estimates have not been validated.[33] In practice, this gap in the literature has often led to idiosyncratic strategies for synthesis that do not support either further research or clinical applications of the work.

The Analytic Approach and Other Study Design Considerations

Suicide is a rare event, and the study of rare but significant events poses difficult problems for conventional parametric statistics.[34] Commonly used logistic regression methods can lead to an underestimation of event probabilities, and logit coefficients in models using rare binary outcomes are often inaccurate when the raw numbers of one outcome (e.g., suicide cases) are disproportionate in comparison to those of a control condition (e.g., "no suicide" cases). Fortunately, these limitations of traditional statistical treatments are now widely recognized,[35,36] and a spirited discussion about potential solutions is underway in the scientific literature.

As early analyses from the Collaborative Program on the Psychobiology of Depression study demonstrated, third-generation prognostic models of risk have the potential to identify dynamic risk factors that are mutable targets for intervention. A longitudinal follow-up study in a cohort of suicide-attempting psychiatric inpatients modeled after this earlier effort may yield further understanding of temporal fluctuations in risk, contributory dynamic risk factors, and the impact on prognosis after pharmacologic and psychological treatments of mutable intervention targets (J. Fawcett, University of New Mexico, personal communication, 2013).

In conjunction with well-defined measures, real-time, nuanced data collection repeated across time in a cohort of suicidal persons through the use of electronic monitoring devices and mobile phones would assist in building a body of work that describes in vivo risk across time.[37] Common data elements are measurement points routinely collected and, in some cases, shared across studies to build data sets with sufficient power to empirically assess the utility of particular suicide risk factors.[38] Finally, well-validated surrogate "end points" or proxy outcome measures can be used in shorter-term or small-sample prospective studies as substitutes for suicide and suicide attempts.[39]

Conclusions

If the history of science teaches one thing, it is that an unsolved problem is not an unsolvable problem. Currently, at least two large suicide prevention research funders list a version of Aspirational Goal 3 among their research priorities.[40,41] With the advent of third-generation risk models, incremental progress toward valid and reliable risk detection is more likely to be achievable, and success in this area of research has the potential to substantially advance capacity for timely, appropriate care. Because dynamic risk elements are by definition modifiable, delineation of such contributors to suicide risk also has the potential to directly inform treatment. Given the critical need, and the emerging tools, further work to improve suicide risk assessment seems particularly strategic at this time.

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