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Letter

Prediction of suicidal behaviour as a three-body problem

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In physics, the three-body problem relates to predicting the trajectories of three (or more) interacting celestial masses based on their initial positions and velocities.[1] A general predictive model for these trajectories is intractable, as predictions are highly sensitive to initial conditions and any minor perturbations lead to wild inaccuracies – that is, the relationships of the orbits of the three bodies are chaotic. The related phenomenon of the butterfly effect indicates that as lead times for prediction increase, the initial conditions bear a diminishing relationship to the outcome.[2]

Although predicting trajectories into suicidal behaviour may be more complex than predicting celestial orbits, these physics problems provide relevant analogies. The constellation of potential factors that may influence the transition from suicidal thoughts to action may be vast. Three intersecting bodies of risk may be represented by the individual, their social relationships and their environment. Minor perturbations in individual state, such as mood, substance use, re-experiencing of trauma or sleep changes may lead to markedly heightened (or reduced risk) of suicide attempt in unpredictable ways. Similarly in the social domain, daily interactions, changes in networks or changes in levels of social contact may substantially influence suicide risk both proximally and distally. Environmental changes, such as fluctuations in financial, work, security or housing status may likewise have volatile effects on suicidal distress. Further complexity is introduced by the interactions between the three intersecting bodies (e.g. change in employment status having an impact on the individual and social domain). This creates a trajectory that is dynamic and non-linear and thus unpredictable.

Much has been written about the intractability of predicting suicide from the perspective of the outcome. Suicide attempts and deaths have a low base rate that results in positive predictive values that are substantially lower than chance even with high sensitivity and specificity,[3] meaning that fewer than half of individuals identified as high risk will go on to attempt suicide. Current predictive models reach nowhere near adequate levels of precision, and frequently misclassify a majority of people who subsequently attempt suicide into the low risk category. Historically, health services have relied heavily on categorising suicide risk in treatment settings in an attempt to reduce uncertainty and for making treatment decisions. This has led to both more restrictive practices than necessary in some cases, and undertreatment in others. Similarly in the research setting, misclassification of risk has excluded many people from being involved in experimental studies and trials that may be helpful for improving treatment and prevention efforts.

Although reviews have considered the challenges of identifying risk factors that predict suicidal behaviour,[4] the tractability of using any combination of risk factors for prediction has received limited attention. There remains a stubborn notion in the literature that we just need to measure more risk factors more often to better predict risk. However, risk factors are often difficult to assess comprehensively using self-report or even digital or biological markers. Most psychological, social and biological risk factors have inconsistent temporal relationships with suicidal behaviour, with a spectrum ranging from proximal (seconds) to distal (decades). In addition, most putative risk factors can fluctuate rapidly and have inconsistent between-person associations with suicidal distress.

Despite these intractable problems with prediction, the scientific literature has a growing focus on suicide prediction. Articles with 'suicid*' and 'predict*' in the title have risen from a mean of 33 per year from 2004 to 2008 to 162 per year from 2019 to 2023 – nearly a fivefold increase over 15 years, which has been partly attributable to a rise in machine learning or artificial intelligence papers. Few if any of these prediction models have been prospectively validated in independent samples or applied to improving clinical outcomes. Use of modelling is too often an exercise in maximising area under the curve, without considering the application of prediction to clinical decision-making or supporting the individual at the right time and in the right place.

It is time for researchers to stop developing new prediction models as a demonstration of advanced statistical techniques without considering how such models will be meaningfully and validly used to improve practice and the lives of those experiencing suicidal distress.[5] Assessment should be used to identify current clinical needs or to identify the roles of modifiable risk factors in suicidal distress, not to make decisions based on a flawed prediction of a future outcome. Better understanding of the limitations of suicide risk prediction among clinicians and services may provide impetus for more joint decision-making with the person at risk.

Fortunately, bad news for prediction may be good news for prevention. Anecdotal reports from participants in our LifeTrack longitudinal cohort study[6] suggest that minor stressors can lead to substantial increases in suicidal distress. Conversely, providing incremental improvements for an individual's state, by intervening to improve their mood, sleep or distress may lead to a markedly positive change in their risk for suicidal behaviour. Compassionate care, additional check-ins, more accessible and diverse services, or implementation of policy to address inequity, disadvantage or discrimination, may also be the 'butterfly wings' that can change an individual's trajectory away from suicidal behaviour.

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