Reevaluating the ‘high-risk’ approach to suicide prevention

Conjoint Professor Matthew Large

UNSW AUSTRALIA

Never Stand Still

Who I am

Psychiatrist in full-time clinical practice

Work in a public hospital in Sydney Australia

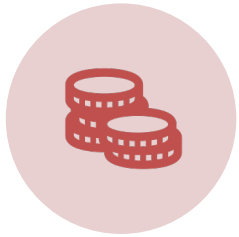
Work in Emergency departments and inpatient wards

Longstanding research interest in suicide

Conflicts of interests/acknowledgment

EMPLOYED BY NSW HEALTH

DERIVE SOME INCOME AS AN EXPERT WITNESS



NO GRANTS OR CORPORATE FUNDING

I WOULD LIKE TO ACKNOWLEDGE MY CO-AUTHORS

This talk covers five areas

1. What is the high - risk approach
2. Overview of the math of risk assessment
3. What science tells us about risk assessment
4. What does the science mean
5. What do we do now?

What is the high - risk approach?

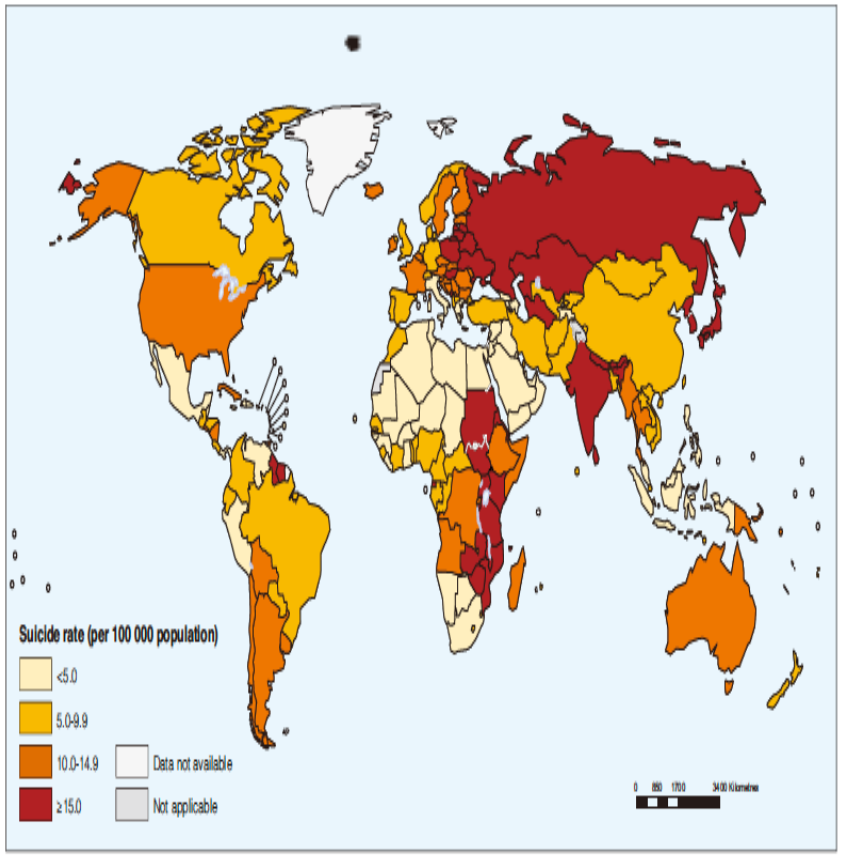
Risk and protective factors, and related interventions

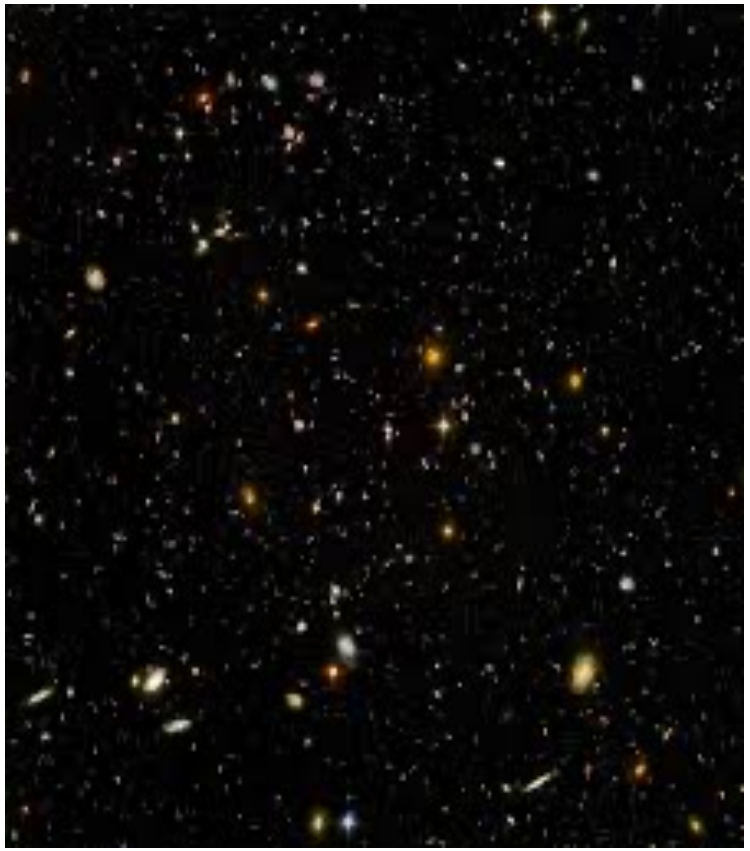
Preventing suicide: A global imperative. WHO 2014

(https://www.who.int/publications/i/item/9789241564779)

Risk Assessment in the current paradigm for suicide prevention	
Universal	designed to reach an entire population, may aim to increase access to health care, promote mental health, reduce harmful use of alcohol, limit access to the means for suicide
Selective	prevention strategies target vulnerable groups
Indicated	target specific vulnerable individuals

‘Universal’ = ‘national’ interventions





Suicide prevention in Australia

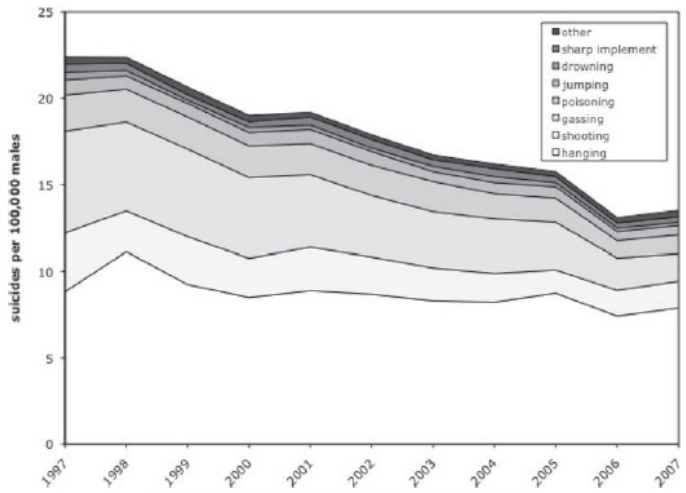
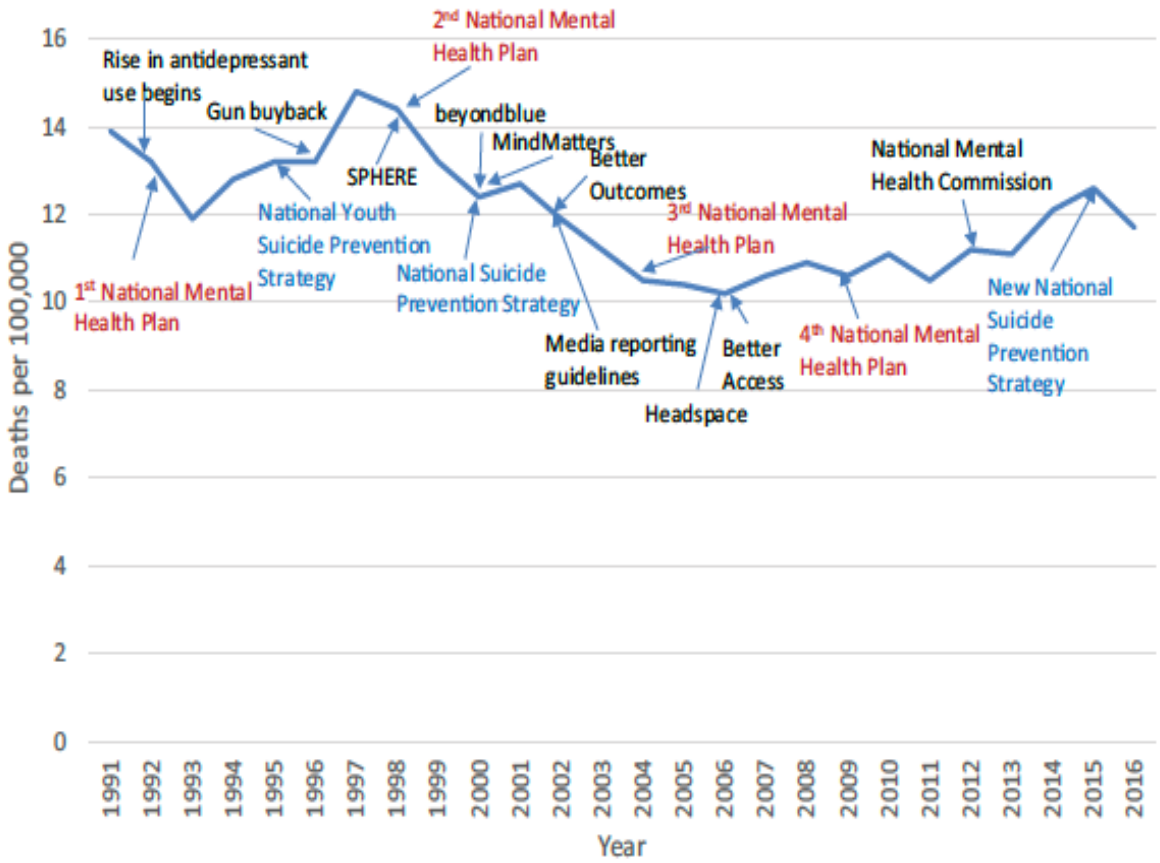


Figure 1. Suicide methods by males 1997–2007.

- Catalytic Converters 1986
- Gun Control 1996/97
- Changes in medication
  - Elimination of barbiturates
  - Pack sizes restricted
  - Less toxic antidepressants
  - Regulation of opiates

17 Australian initiatives

Figure 1. Historical changes in the suicide rate in Australia, showing the points at which various interventions and plans were introduced. Descriptions of the interventions are given in Supplementary File 1.



Selected interventions

Actual

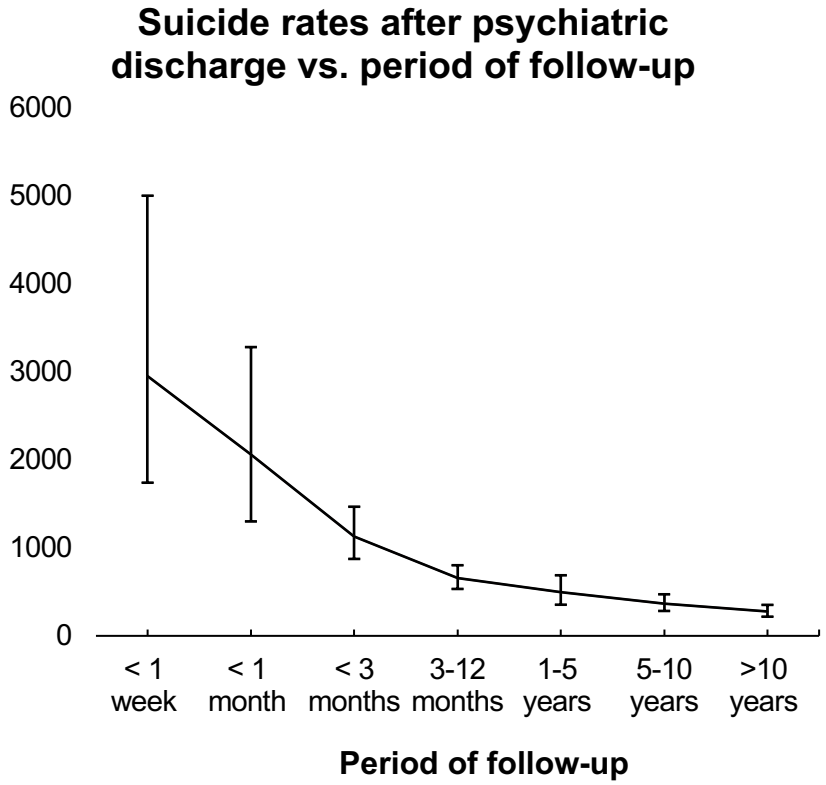
- Reducing ligature points in hospitals
- Seven day follow up of discharged patients

Hypothetical

- Preventing men from owning guns
- Measures for groups high-risk patients

Vulnerable groups

Chung et al. 2017/19



Walsh et al. 2015

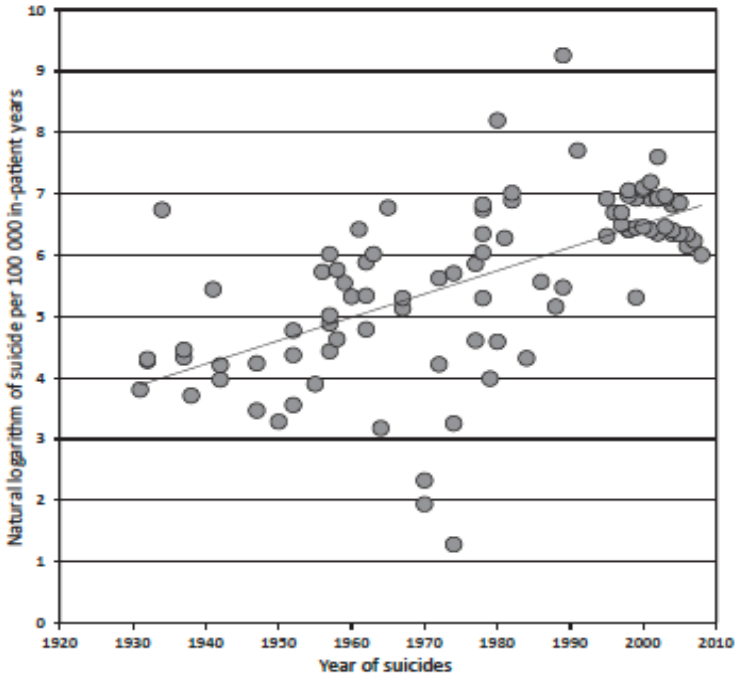


Fig. 2. Scatter plot of suicide per 100 000 in-patient years and year of suicide.

Indicated interventions rely on risk assessment

High-risk approach guides prevention to groups and individuals at a higher probability of suicide

In theory, it could guide selected interventions

However, we treat people = indicated interventions

Understanding the metrics

2 X 2 contingency table

	Lower-risk	Higher-Risk
Survives	True Negative	False Positive
Suicide	False Negative	True Positive

Sensitivity

	Lower-risk	Higher-Risk	Sensitivity
Survives	True Negative	False Positive	
Suicide	False Negative	True Positive	TP/ (TP+FN)

Sensitivity is the proportion of suicides in a higher-risk category

Odds Ratio (OR)

	Lower-risk	Higher-Risk	Odds Ratio
Survives	True Negative	False Positive	(TP/FP)/ (FN/TN)
Suicides	False Negative	True Positive	

OR is the ratio of odds of suicide in lower and higher risk groups.

OR > 1 suggests a higher proportion of suicides in the higher risk group.

Positive Predictive Value (PPV)

	Lower-risk	Higher-Risk
Survives	True Negative	False Positive
Suicides	False Negative	True Positive
Positive Predictive Value =		TP/(TP+FP)

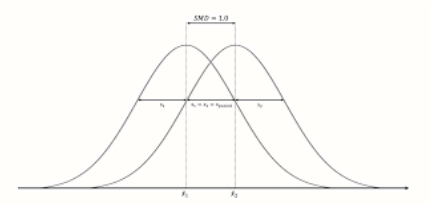
PPV is the probability that a higher risk case will suicide

Measures of discrimination

- Sensitivity and Specificity
- AUC and OR, and others SMD,IRR,HR.
- Quantify the strength of the association between two events
- In Bayesian terms, it is the amount of new information contingent on new knowledge

Discrimination

- Quantifies the strength of the risk assessment to distinguish between lower and higher risk groups.
- In Bayesian terms, it is the amount of new information contingent on new knowledge.
- Is not a test of the accuracy of a higher-risk categorization



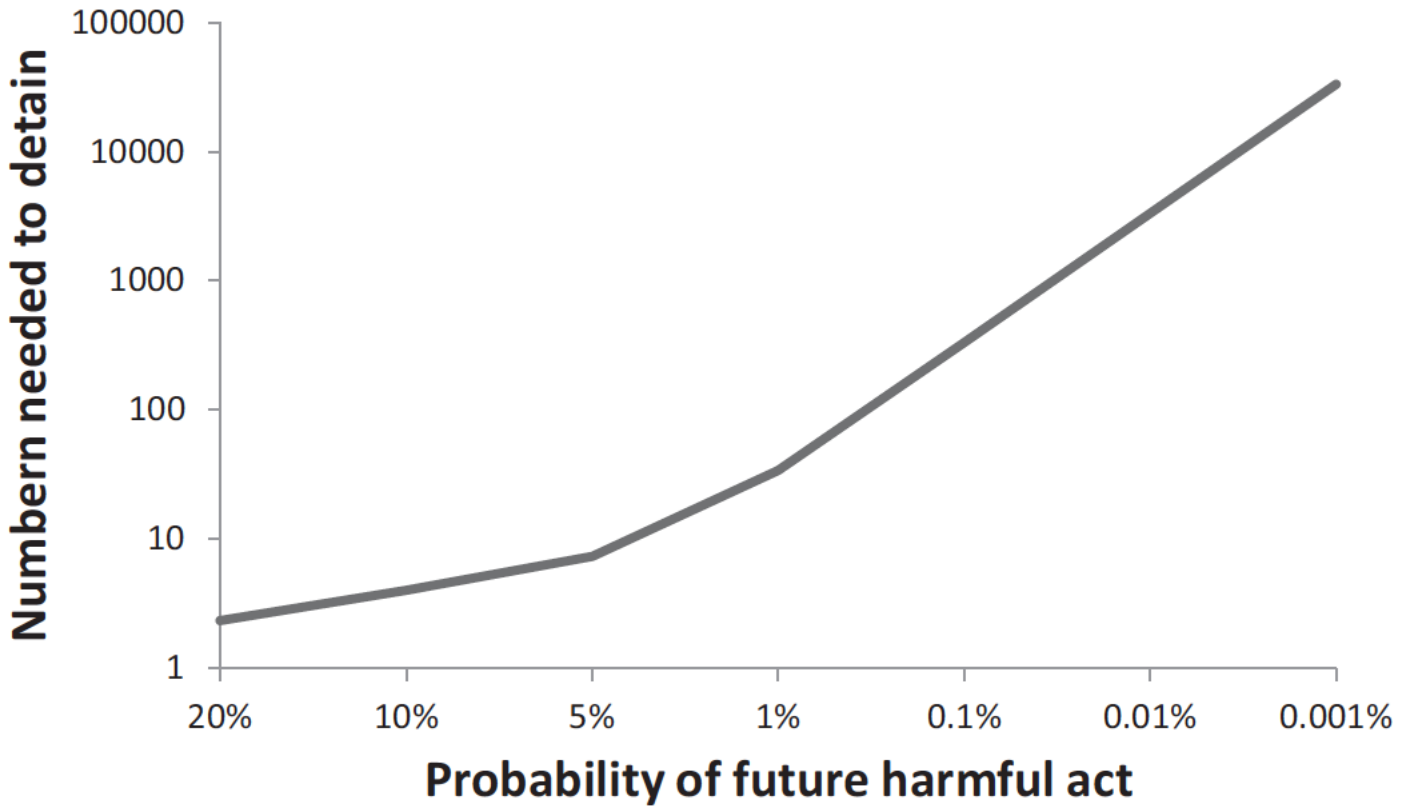
Calibration

- How a risk assessment works in practice
- Depends on base rate
- Positive Predictive Value (PPV)
- Negative Predictive Value
- Number Needed to Predict =1/ PPV

PPV and NNP

- In Bayesian terms, PPV is the contingent probability
- PPV is the test of a risk assessment in practice.
- 1/PPV = N. of false positives per true positive (NNP)
- The Number Needed to Predict is the number of people exposed to high-risk guided interventions to treat one person and is linearly dependent on the base rate (prior probability)

Base rate and NNP



Metrics measured by meta-analyses

- Large et al. 2016 *PloS ONE,* 11:e0156322.
- Franklin & Ribiero et al. 2016, 2017
  Psychol Med, 46:225-36.;
  Psychol Bull, 143 :187-232
- Corke et al. 2021 *BJPsych Open* 7, e26:1–11.
- Belsher et al. 2019 *JAMA Psychiatry*, 76:643-651

Metrics of suicide risk assessment

RESEARCH ARTICLE

Meta-Analysis of Longitudinal Cohort Studies of Suicide Risk Assessment among Psychiatric Patients: Heterogeneity in Results and Lack of Improvement over Time

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Abstract

Objective

It is widely assumed that the clinical care of psychiatric patients can be guided by estimates of suicide risk and by using patient characteristics to define a group of high-risk patients. However, the statistical strength and reliability of suicide risk categorization is unknown. Our objective was to investigate the odds of suicide in high-risk compared to lower-risk categories and the suicide rates in high-risk and lower-risk groups.

Risk Factors for Suicidal Thoughts and Behaviors: A Meta-Analysis of 50 Years of Research

Joseph C. Franklin and Jessica D. Ribeiro
Vanderbilt University and Harvard University

Kathryn R. Fox
Harvard University

Kate H. Bentley
Boston University

Evan M. Kleiman
Harvard University

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Vanderbilt University

Adam C. Jaroszewski
Harvard University

Bernard P. Chang
Columbia University Medical Center

Matthew K. Nock
Harvard University

Suicidal thoughts and behaviors (STBs) are major public health problems that have not declined appreciably in several decades. One of the first steps to improving the prevention and treatment of STBs is to establish risk factors (i.e., longitudinal predictors). To provide a summary of current knowledge about risk factors, we conducted a meta-analysis of studies that have attempted to longitudinally predict a specific STB-related outcome. This included 365 studies (3,428 total risk factor effect sizes) from the past 50 years. The present random-effects meta-analysis produced several unexpected findings: across odds ratio, hazard ratio, and diagnostic accuracy analyses, prediction was only slightly better than chance for all outcomes; no broad category or subcategory accurately predicted far above chance levels; predictive ability has not improved across 50 years of research; studies rarely examined the combined effect of multiple risk factors; risk factors have been homogenous over time, with 5 broad categories accounting for nearly 80% of all risk factor tests; and the average study was nearly 10 years long, but longer studies did not produce better prediction. The homogeneity of existing research means that the present meta-analysis could only speak to STB risk factor associations within very narrow methodological limits—limits that have not allowed for tests that approximate most STB theories. The present meta-analysis accordingly highlights several fundamental changes needed in future studies. In particular, these findings suggest the need for a shift in focus from risk *factors* to machine learning-based risk *algorithms*.

Keywords: meta-analysis, prediction, risk factors, suicidal behavior, suicide

JAMA Psychiatry | Review

Prediction Models for Suicide Attempts and Deaths
A Systematic Review and Simulation

Bradley E. Belsher, PhD; Derek J. Smolenski, PhD, MPH; Larry D. Pruitt, PhD; Nigel E. Bush, PhD; Erin H. Beech, MA; Don E. Workman, PhD; Rebecca L. Morgan, PhD, MPH; Daniel P. Evatt, PhD; Jennifer Tucker, PhD; Nancy A. Skopp, PhD

IMPORTANCE Suicide prediction models have the potential to improve the identification of patients at heightened suicide risk by using predictive algorithms on large-scale data sources. Suicide prediction models are being developed for use across enterprise-level health care systems including the US Department of Defense, US Department of Veterans Affairs, and Kaiser Permanente.

OBJECTIVES To evaluate the diagnostic accuracy of suicide prediction models in predicting suicide and suicide attempts and to simulate the effects of implementing suicide prediction models using population-level estimates of suicide rates.

EVIDENCE REVIEW A systematic literature search was conducted in MEDLINE, PsycINFO, Embase, and the Cochrane Library to identify research evaluating the predictive accuracy of suicide prediction models in identifying patients at high risk for a suicide attempt or death by suicide. Each database was searched from inception to August 21, 2018. The search strategy included search terms for suicidal behavior, risk prediction, and predictive modeling. Reference lists of included studies were also screened. Two reviewers independently screened and evaluated eligible studies.

FINDINGS From a total of 7306 abstracts reviewed, 17 cohort studies met the inclusion criteria, representing 64 unique prediction models across 5 countries with more than 14 million participants. The research quality of the included studies was generally high. Global classification accuracy was good (≥0.80 in most models), while the predictive validity associated with a positive result for suicide mortality was extremely low (≤0.01 in most models). Simulations of the results suggest very low positive predictive values across a variety of population assessment characteristics.

Supplemental content

Review

Meta-analysis of the strength of exploratory suicide prediction models; from clinicians to computers

Michelle Corke, Katherine Mullin, Helena Angel-Scott, Shelley Xia and Matthew Large

Background
Suicide prediction models have been formulated in a variety of ways and are heterogeneous in the strength of their predictions. Machine learning has been a proposed as a way of improving suicide predictions by incorporating more suicide risk factors.

Aims
To determine whether machine learning and the number of suicide risk factors included in suicide prediction models are associated with the strength of the resulting predictions.

Method
Random-effect meta-analysis of exploratory suicide prediction models constructed by combining two or more suicide risk factors or using clinical judgement (Prospero Registration CRD42017059665). Studies were located by searching for papers indexed in PubMed before 15 August 2020 with the term suicid* in the title.

Results
In total, 86 papers reported 102 suicide prediction models and included 20 210 411 people and 106 902 suicides. The pooled odds ratio was 7.7 (95% CI 6.7–8.8) with high between-study heterogeneity ($I^2 = 99.5$). Machine learning was associated with a non-significantly higher odds ratio of 11.6 (95% CI 6.0–22.3) and clinical judgement with a non-significantly lower odds ratio of 4.7 (95% CI 2.1–10.9). Models including a larger number of suicide risk factors had a higher odds ratio when machine-learning studies were included ($P = 0.02$). Among non-machine-learning studies, suicide prediction models including fewer risk factors performed just as well as those including more risk factors.

Conclusions
Machine learning might have the potential to improve the performance of suicide prediction models by increasing the number of included suicide risk factors but its superiority over other methods is unproven.

Keywords
Suicide; risk assessment; self-harm; suicide attempt.

Franklin & Ribeiro. 2016 & 2017

- Longitudinal Prediction of Suicide Outcomes
- Meta-analysis of risk factors for
  - Suicidal ideas
  - Suicidal behavior
  - Suicide
- Non-specified populations
- Huge and sophisticated research effort

Explosion of research

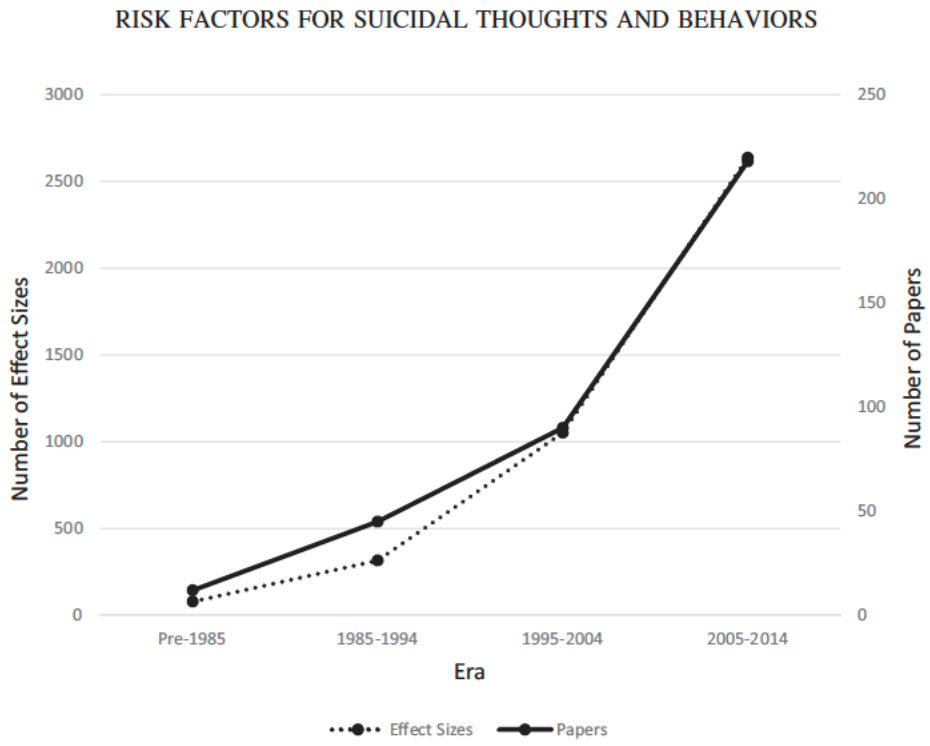


Figure 2. Number of papers and effect sizes across each era of STB research.

Franklin & Ribeiro. 2016 & 2017

- 365 studies and 912 risk estimates for suicide as an outcome
- Detailed examination of moderators

Strength of Suicide Risk Factors in Longitudinal Studies			
	Samples	OR	95%CI
Psychiatric hospitalization	31	3.57	2.81-4.53
Prior suicide attempt	19	2.24	1.69-2.97
Prior suicidal ideation	10	2.22	1.45-3.41
Lower socio-economic status	10	2.20	1.32-3.67
Stressful life events	23	2.18	1.63-2.93

Franklin & Ribeiro. 2016 & 2017

Conclusions: “The present random-effects meta-analysis produced several unexpected findings: across odds ratio, hazard ratio, and diagnostic accuracy analyses, prediction was only slightly better than chance for all outcomes; no broad category or subcategory accurately predicted far above chance levels; predictive ability has not improved across 50 years of research”

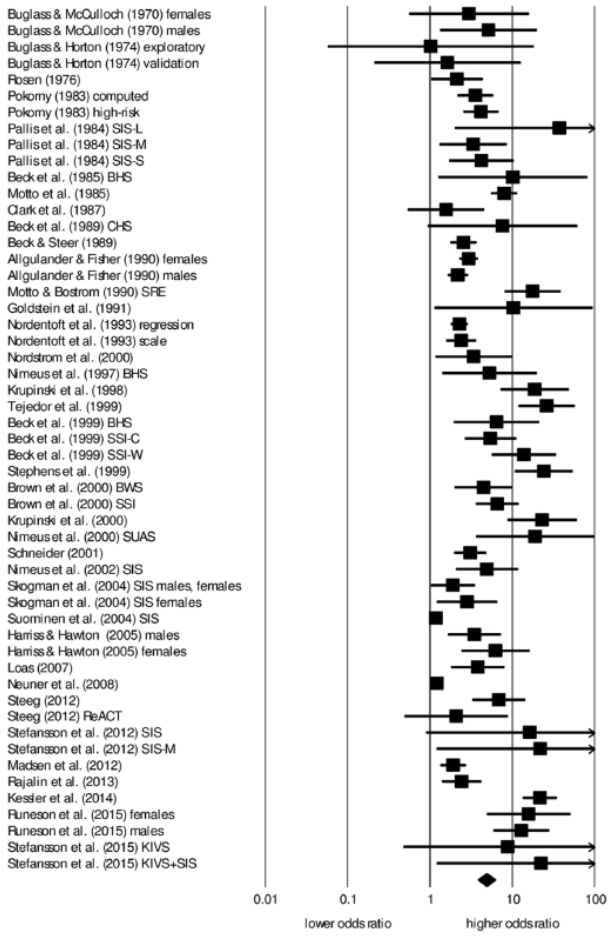
Large et al. 2016

- Risk categorization is defined as ≥2 risk factors
- Psychiatric patients
- longitudinal cohorts
- Subgroups
  - experimental - retrospective prediction models
  - Validation – prospective prediction models
- Meta-regression
  - year of publication, number of factors in models

Large et al. 2016

- 53 models in 37 studies, 1975-2015
- 3114 suicides among 315,309 people (≈ 1%)

Large et al, 2016



Large et al. 2016

- OR = 4.84 (95% CI 3.79-6.20), I-square = 93
- Sensitivity = 56%, Specificity = 79%
- PPV = 5.5%, over ≈ 5-year follow-up.
-
- Subgroups
  - Exploratory (OR = 5.13) vs Validation (OR = 4.68), (p=NS)
- Meta-regression
  - No improvement over 40 years
  - More complex models did not have a higher OR

Followed by two other papers (Chan 2016, Carter 2017)

MARCH 28, 2017 | 4 MIN READ

Suicide Risk Assessment Doesn't Work

New research suggests it doesn't help—and it may hurt—to rely on a formula to predict the risk of a suicide

BY DECLAN MURRAY & PATRICK DEVITT

For illustration purposes only. Getty Images

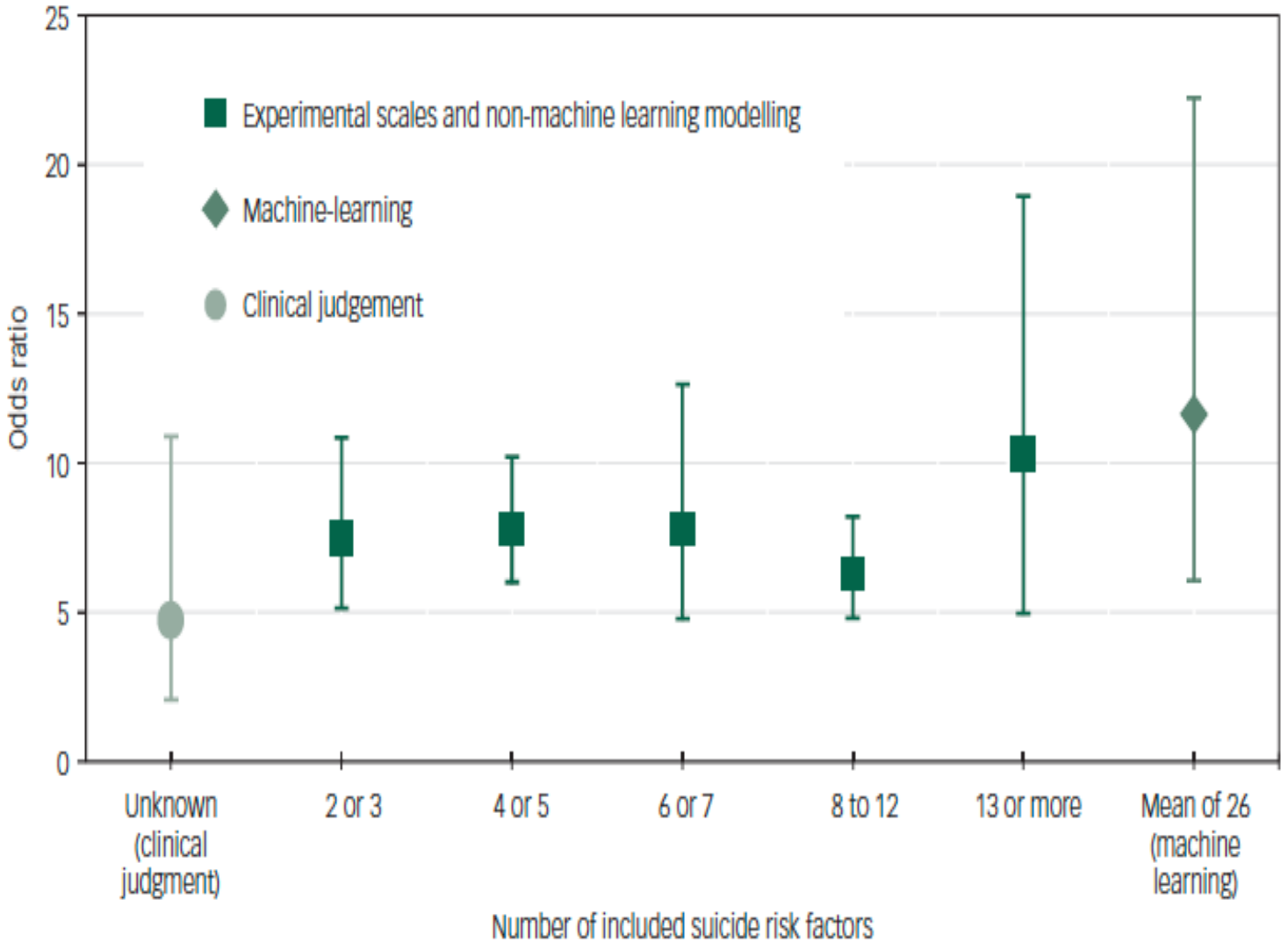
Corke et al. 2021

- Suicide prediction models (SPM) ≈ suicide risk categorization ≈ high-risk models
- Cohort and Control designs
- Exploratory models only
- Included all types of models from clinical judgment to Machine Learning
- Not selected by population

Corke et al. 2021

- 86 papers reporting 102 SPM's
- 20,210,411 people /106 902 suicides (≈.5%)
- OR = 7.7 (95% CI = 6.7-8.8), I^2 = 99%
- Sensitivity = 44%, Specificity = 84%
- Pooled AUC = .79
- PPV = 2.8% over five years

Corke et al. 2021

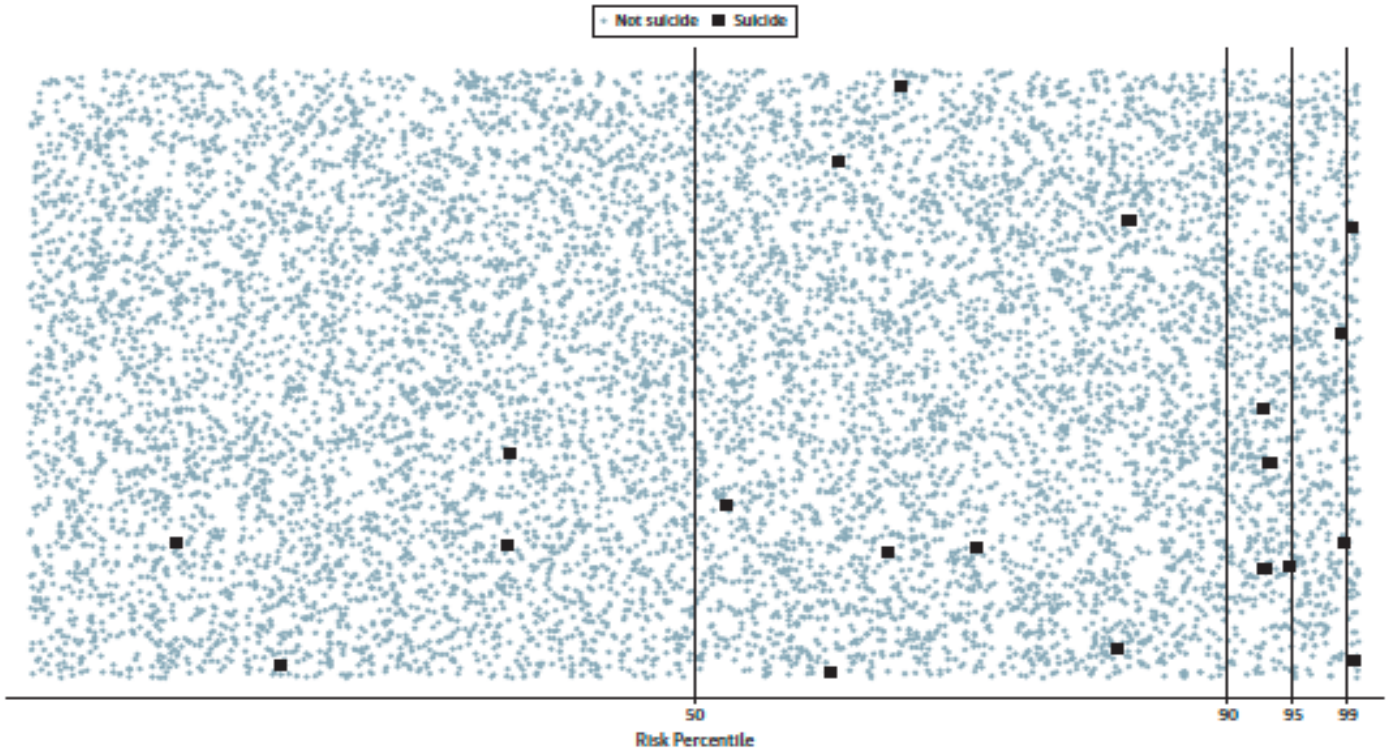


Belsher et al. 2019

- Longitudinal Prediction of SPM's
- Validated SPM's only (C/W Corke et al.)
- Adults over 18
- Included 11 studies with suicide outcomes
- These studies were used to form a 'Simulation'

Belsher et al. 2019

Figure 2. Illustration of Implementing a Suicide Prediction Model



The number of suicides that would be detected in a population of 10 000 individuals with a suicide mortality of 20 per 10 000 is indicated. Note that the adult US population rate is closer to 1.7 per 10 000. Moving the threshold across the risk percentile affects both the sensitivity and the specificity. The positive predictive value decreases as the threshold decreases since the small number of true events are masked by increasingly large numbers of noncases incorrectly classified as at risk. Individuals to the right of a cut point are classified as at risk.

Belsher et al. 2019

Results: "Global classification accuracy was good (0.80 in most models), while the predictive validity associated with a positive result for suicide mortality was extremely low (0.01 in most models). Simulations of the results suggest very low positive predictive values across a variety of population assessment characteristics.

Belsher et al. 2019

Results: "Global classification accuracy was good (0.80 in most models), while the predictive validity associated with a positive result for suicide mortality was extremely low (0.01 in most models). Simulations of the results suggest very low positive predictive values across a variety of population assessment characteristics.

Conclusions: *"To date, suicide prediction models produce accurate overall classification models, but their accuracy of predicting a future event is near 0."*

Near zero!

Summary of 50 years research

- No improvement over 50 years
- Individual risk factors are modestly associated with suicide
- SPM's have a limited sensitivity (≈ 50%) and a low PPV (≈1% pa)
- NNP's are very high (likely in the 1000's per month)
- Knowing more will not necessarily help you

Summary of 50 years research

	People	Suicides	Long term PPV
Lower Risk	≈80 %	≈50 %	≈1 %
Higher Risk	≈20 %	≈50 %	≈5%

What does this mean?

Classification is a human enterprise

- An intervention for higher-risk people must be sufficiently effective and not so burdensome in terms of cost and side effects such that it will suit the overwhelming majority of higher-risk people who will not suicide.

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- If such an effective and non-burdensome intervention exists, how can it be rationally denied to lower-risk patients among whom 50% of suicides occur?

Classification is a human enterprise

- An intervention for higher-risk people must be sufficiently effective and not so burdensome in terms of cost and side effects such that it will suit the overwhelming majority of higher-risk people who will not suicide.

- If such an effective and non-burdensome intervention exists, how can it be rationally denied to lower-risk patients among whom 50% of suicides occur?

- If there is no such intervention, what is a risk assessment for?

AMERICAN PSYCHOLOGICAL ASSOCIATION

Psychological Bulletin

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Interventions for Suicide and Self-Injury: A Meta-Analysis of Randomized Controlled Trials Across Nearly 50 Years of Research

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Eleonora M. Guzmán
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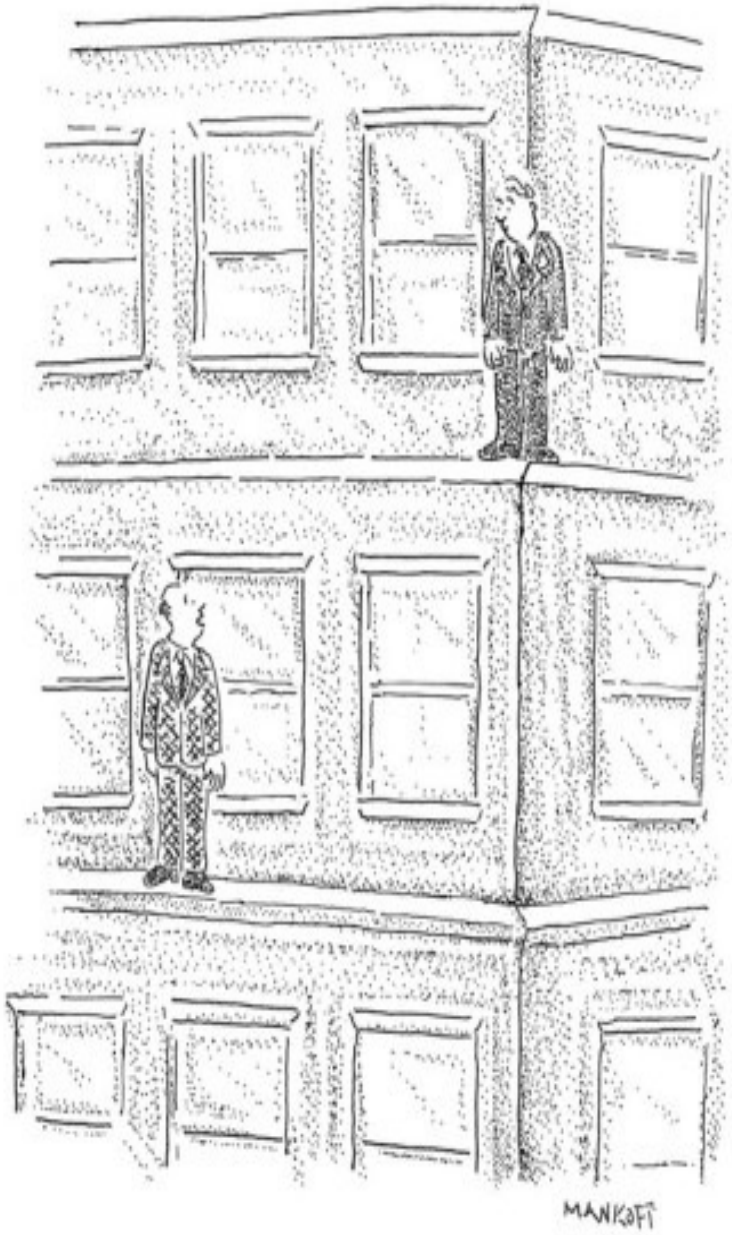
Florida State University

Self-injurious thoughts and behaviors (SITBs) are major public health concerns impacting a wide range of individuals and communities. Despite major efforts to develop and refine treatments to reduce SITBs, the efficacy of SITB interventions remains unclear. To provide a comprehensive summary of SITB treatment efficacy, we conducted a meta-analysis of published randomized controlled trials (RCTs) that have attempted to reduce SITBs. A total of 591 published articles from 1,125 unique RCTs with 3,458 effect sizes from the past 50 years were included. The random-effects meta-analysis yielded surprising findings: The overall intervention effects were small across all SITB outcomes; despite a near-exponential increase in the number of RCTs across five decades, intervention efficacy has not improved; all SITB interventions produced similarly small effects, and no intervention appeared significantly and consistently stronger than others; the overall small intervention effects were largely maintained at follow-up assessments; efficacy was similar across age groups, though effects were slightly weaker for child/adolescent populations and few studies focused on older adults; and major sample and study characteristics (e.g., control group type, treatment target, sample size, intervention length) did not consistently moderate treatment efficacy. This meta-analysis suggests that fundamental changes are needed to facilitate progress in SITB intervention efficacy. In particular, powerful interventions target the necessary causes of pathology, but little is known about SITB causes (vs. SITB correlates and risk factors). The field would accordingly benefit from the prioritization of research that aims to identify and target common necessary causes of SITBs.

Fox et al.

" The overall intervention effects were small across all SITB outcomes; despite a near exponential increase in the number of RCTs across five decades, intervention efficacy has not improved; all SITB interventions produced similarly small effects, and no intervention appeared significantly and consistently stronger than others.."



"Oh, fine, thanks. And yourself?"

What do we do now?

Stakeholders

- Yourself
- Patients
- Families
- Students and colleagues
- Third-Party Providers
- The Judiciary
- Media

What we need to do?

- Educate yourself

What we need to do?

- Educate yourself
- Use your capacity for slow thinking

What we need to do?

- Educate yourself
- Use your capacity for slow thinking
- Keep calm

What we need to do?

- Educate yourself
- Use your capacity for slow thinking
- Keep calm
- Accept complexity, uncertainty

Pokorny 1983

"The conclusion is inescapable that we do not possess any item of information or any combination of items that permit us to identify to a useful degree the particular persons who will commit suicide"

"the concept of prediction may not even apply; rather, one is required to identify a suicidal crisis that is already here, a task involving a different set of concepts and clinical skills."

Some Helpful Concepts

- Thinking Fast and Slow
- Prospect Theory
- Evolved Protections Against Suicide
- Calibration Vs Discrimination
- Aleatory Vs Epistemic Uncertainty
- Determinism Vs Human Agency
- Therapeutic Narcissism/Grandiosity

Assuming you are a clinician

Large, Ryan, Carter, Kapur. BMJ 2017 Oct 17:359:j4627

Box 2: How to approach a patient who you think might be suicidal

- Conduct a respectful, thorough, and sympathetic assessment using active listening
- Keep a focus on the content and nature of the doctor-patient interaction
- Try to understand and address the individual circumstances that are distressing the patient
- Identify the patient's current treatment needs, including common modifiable social and clinical factors for suicide
- Do not attempt to stratify patients into high and low risk categories
- Do not simply rely on the patient's expression or non-expression of suicide plans and ideas
- Never dismiss any patient who raises your concern about suicide as low risk
- Talk with the patient's family or friends
- Ask about firearms and other lethal methods of methods of suicide
- Involuntary hospitalisation should be used sparingly and with great care
- Negotiate a management plan with every patient
- Document your assessment, reasoning, and treatment plan

Patients and Families

- Talk about absolute risk
- Stress the limitations of prediction
- Use your therapeutic skills to deal with anxiety

Students and Colleagues

Max Plank

"A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die and a new generation grows up that is familiar with it"

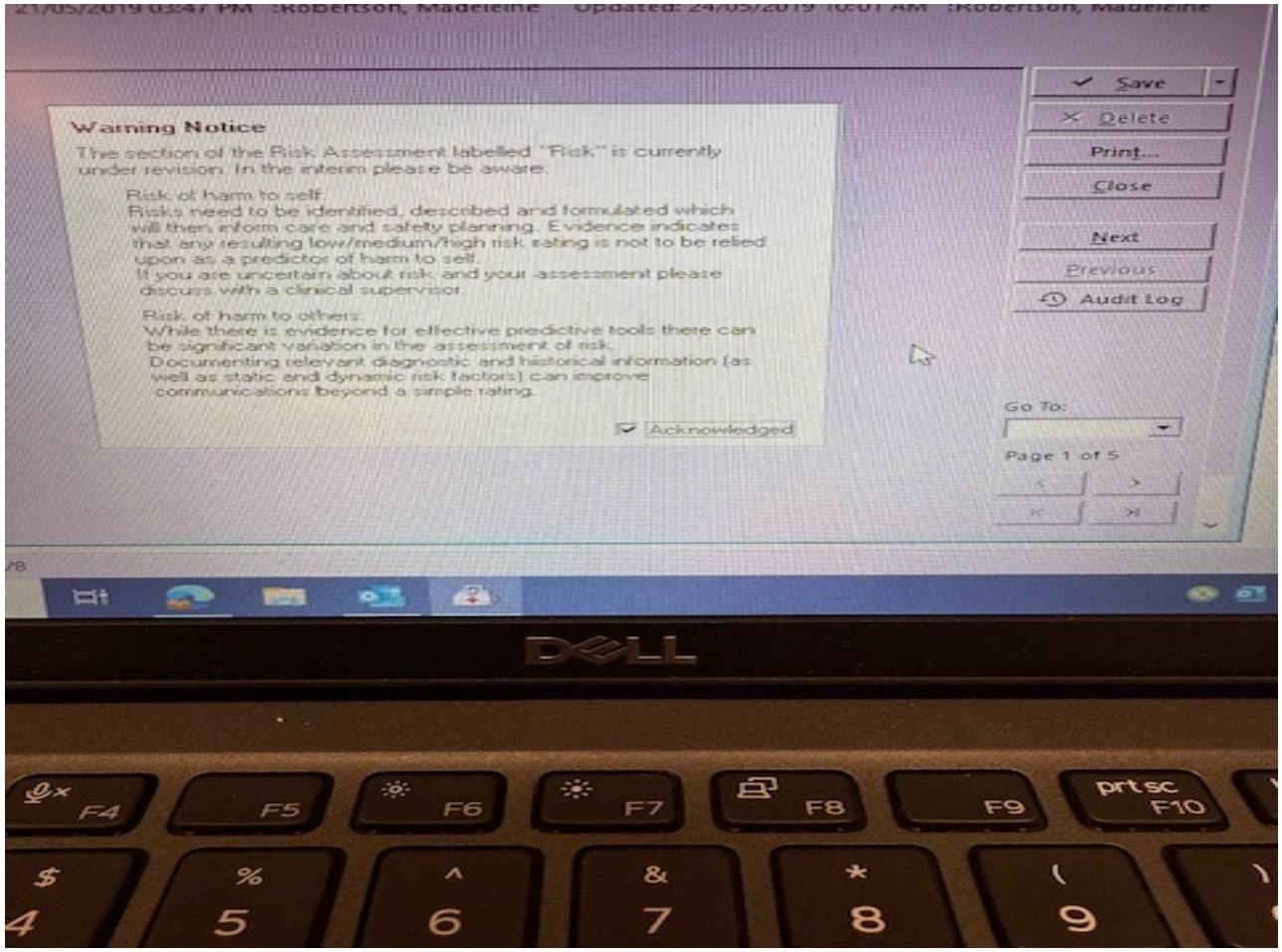
Schopenhauer/Bernal

- It is not true.
- It is true but not important.
- It is important but not original.
- It is what I have always believed.

Third-party providers

- Healthcare providers use a wide range of non-evidence-based tools.
- These need to be abandoned/contextualized
- Cardiology services do not admit based on Framingham
- Patience is required with organizations

This is from an Australian State!



The courts/law

- Local investigations in hospitals and prisons
- Coroner's courts
- Civil Proceedings for compensation
- Criminal Prosecutions

Media

MEDIA MONITORS

Sydney Morning Herald
14/07/2011
Page: 21
By: Amy Corderoy
Section: Health & Science
Region: Sydney Circulation: 209644
Type: Capital City Daily
Size: 232.00 sq.cms
Frequency: MTWTFS-

Poor prediction no substitute for giving patients better tools

Amy Corderoy

WHEN mental illness ends in tragedy, observers are often left asking why no one saw it coming.

In last year's inquest into the suicide of the newsreader Charmaine Dragun, family and friends questioned why no one had predicted her suicide. And during the trial this year of Anthony Waterlow, who was found not guilty by reason of mental illness of murdering his father and sister, friends of the family criticised health authorities for not having the foresight to forcibly detain him in hospital.

But is such foresight possible? Some Sydney psychiatrists, with international colleagues, say we should abandon the idea that we can predict such events, rather than trying to improve methods of doing so.

In a study released this week a clinical senior lecturer at the University of NSW, Dr Matthew Large, found there was no factor, or combination of factors, that could clearly predict which patients who have previously harmed themselves, who lack support networks or who are severely depressed.

The problem, Large says, is that the great majority of patients who have these and other "risk factors" will not go on to commit suicide. "It is a needle in a haystack problem," he says.

His study, published in the *Australian and New Zealand Journal of Psychiatry*, found that only 3 per cent of patients classified as high risk went on to kill themselves. And 60 per cent of people who did so were likely to be classified as low risk.

Risk assessments in hospitals have led to misallocation of resources and to a great deal of guilt among friends, families and medical professionals.

"I'm concerned about family members thinking they should have seen this would happen or should have done something differently," he says.

Large argues doctors should

Review Tribunal assesses whether a patient should be given compulsory treatment, its members must take into account that person's risk of harming others. Yet only a minuscule proportion of people with a mental illness will become violent.

A practising psychiatrist and honorary associate at the University of Sydney, Christopher Ryan, says detaining people on that basis is a form of "sanism", which would be unacceptable if applied to sufferers of any other illness.

He argues patients should be assessed for involuntary treatment based on their capacity to consent to treatment, not on whether they may harm themselves or others.

This year Victoria and Tasmania have released reviews of their mental health acts, which have shifted towards the idea of capacity.

Both doctors argue their approaches are about moving away

Researchers

- More involvement of patients
- Novel Risk Factors
- Novel SPM with AI
- Real-time monitoring
- More humane and less traumatic care
- Continued meta-analysis of primary studies

Recap of five areas

1. The high-risk approach needed to be better thought out.
2. The math is easy, but it needs to be considered.
3. Risk assessment has modest discrimination and terrible results when calibrated for base rates.
4. Risk assessment is a poor basis for deciding on the use of weak treatments
5. What do we do now?

“Risk is a many-headed hydra”